Food safety plans for abalone farms

Contents

Food safety plans for abalone farms

Background

Food Safety Plans (FSPs) are fast becoming a prerequisite for domestic and international trade. In the present context, abalone farmers applied to the Fisheries Research and Development Corporation (FRDC) for funding with the Abalone Aquaculture Subprogram for development of FSP to cover all aspects of farming and processing of abalone. The program began in April, 2000 and a generic set of plans for a mythical farm, Aussie Abs Pty Ltd, is presented.

The system comprises three major elements:

Risk Assessment
Hazards and risks associated with the abalone business

Abalone processing system
- Standard Sanitation Operating Procedures (SSOPs)
- Process control manual
- HACCP manual

Abalone farming system
- Standard Sanitation Operating Procedures (SSOPs)
- Process control manual
- HACCP manual

HACCP

The system is based on the Hazard Analysis Critical Control Point (HACCP) concept, the elements of which are presented below, with the seven HACCP principles contained within the box.

Assemble the HACCP team
Describe each product type and its intended use
Construct process flow diagram and verify on site

List potential hazards and assess risks Determine Critical Control points (CCPs) Establish critical limits for each CCP
Set up monitoring and checking system for each CCP
Establish corrective actions
Establish verification systems
Maintain records

Train staff in operating the system

SSOPs

The series of Pre-Requisite Programs (called Sanitation Standard Operating Procedures - SSOPs - in USA) is directed at ensuring clean, well-designed premises in which operations are planned to avoid cross contamination of final products.
SSOPs include:

- Safety of the water supply.
- Condition and cleanliness of food contact surfaces.
- Prevention of cross-contamination from insanitary objects and maintenance of hand washing, hand sanitising, and toilet facilities.
- Protection of food, food packaging materials, and food contact surfaces from adulteration with lubricants, fuel, pesticides, cleaning compounds, sanitising agents, condensate, and other chemical, physical, and biological contaminants.
- Proper labelling, storage, and use of toxic compounds.
- Control of employee health.
- Exclusion of pests.

Hazard identification

The following hazards may reasonably be expected to occur during production and processing of abalone:

Biological hazards

Bacterial pathogens naturally-occurring in the environment:

- *Clostridium botulinum*
- *Vibrio parahaemolyticus*
- *Vibrio vulnificus*
- *Aeromonas*
- *Listeria monocytogenes*

Control of these hazards is during the processing phase, with Critical Control Points (CCPs) in the thermal process specifically designed to ensure commercial sterility.

Chemical hazards

Chemicals which may accumulate in abalone during production include:

- Agricultural chemicals e.g. Organochlorine residues
- Metals e.g. Lead, cadmium, copper, arsenic etc.
- Antibiotics e.g. oxolinic acid and oxytetracycline
- Anaesthetics e.g. alcohol, carbon dioxide, magnesium sulphate and benzocaine
- Biotoxins produced during algal blooms

Physical hazards

Foreign matter may be introduced during processing:

- Glass, wood, bone, metal, plastic
- Pests, their parts or their excreta

Physical hazards are controlled in the FSP under pre-requisite programs for construction and operation of the processing facility.

Hazards and risks in abalone farming and processing

October, 2000

Contents

Hazard identification

The following hazards may reasonably be expected to occur during production and processing of abalone:

Biological hazards

Bacterial pathogens naturally-occurring in the environment:

- *Clostridium botulinum*
- *Vibrio parahaemolyticus*
- *Vibrio vulnificus*
- *Aeromonas*
- *Listeria monocytogenes*

Bacterial pathogens transmitted during processing

- *Staphylococcus aureus*

Chemical hazards

Chemicals which may accumulate in abalone during production include:

- Agricultural chemicals
- Metals
- Antibiotics
- Biotoxins produced during algal blooms
- Anaesthetics

Physical hazards

Foreign matter which may be introduced during processing includes:

- Glass, wood, bone, metal, plastic
- Pests, their parts or their excreta

Biological hazards

Pathogenic bacteria which occur naturally in the marine environment, or which can contaminate the abalone during processing include:

Clostridium botulinum

Clostridium botulinum is the cause of food-borne botulism, an illness which can be fatal, due to a neurotoxin which paralyses the chest muscles, leading to asphyxiation and death. Even with treatment, the death rate is 20-40%. The aquatic environment is contaminated with *C. botulinum* and this is the source of contamination of seafoods. The prevalence of *C. botulinum* (Type B and Type E) is considered to be low in Australian waters but this is offset by the severity of botulism.

The bacterium grows only in the absence of oxygen. In products from which oxygen is excluded (vacuum packed or canned) the bacterium makes a toxin which is the cause of botulism. The toxin is heat labile and only uncooked products remain toxic. There have been well-documented outbreaks of botulism from canned, vacuum-packed and smoked seafoods, each of which has been traced to process or storage failure. Abalone is processed in formats (canned, vacuum-packed) which have the potential to allow formation of botulin toxin and the hazard (*C. botulinum*) requires Critical Control Points (CCPs) in the process and transport phases. During the early stages of abalone processing (shelling, packing, transport) the CCP is temperature control to prevent growth of the bacterium and consequent toxin formation. The CCP at the cannery is the thermal process to eliminate all cells and spores of *C. botulinum*, together with any preformed toxin.

Listeria monocytogenes
This organism is ubiquitous and, as it has salt tolerance, it can be part of the marine environment. It causes listeriosis, symptoms of which include septicemia, meningitis, and intra-uterine or cervical infections in pregnant women, which may cause spontaneous abortion or stillbirth. Infections of less vulnerable people are mild to acute influenza-like symptoms. *Listeria monocytogenes* is regularly present on raw seafoods (and meat, poultry, milk, vegetables) and may be expected to contaminate abalone. The bacterium is killed during cooking. Critical Control Points in processing are based on maintaining the storage temperature close to 0°C.

Vibrio parahaemolyticus
The organism has marine distribution and regularly contaminates raw seafoods. It produces a toxin which causes mild-acute gastroenteritis. Food poisoning due to *V. parahaemolyticus* is usually the consequence of high (>20°C) ambient temperatures so chilling is a CCP. It is also a disease-agent for farmed abalone if water temperatures exceed 20°C.

Vibrio vulnificus
This organism is common in the marine environment and causes wound infections leading to mortality in 25-50% of patients. Symptoms include blisters and ulcers on the extremities together with systemic infections which may be fatal. Infections have occurred from finfish and crustaceans. The organism grows rapidly above 20°C.

Aeromonas
Members of the genus, including *A. hydrophila*, *A. sobria* and *A. caviae* are contaminants of marine and freshwater species. These organisms cause symptoms ranging from vomiting and diarrhoea in immunocompetent individuals to wound infections in the immunocompromised. The organisms are psychrotrophic and salt tolerant.

Staphylococcus aureus
Staphylococcus is widely found in nature, and is also closely associated with humans, being found on the skin, particularly in warm, damp areas such as nose, ears and armpits and the hands so that food handlers are the prime source of contamination. The most common type is *Staphylococcus aureus* (sometimes called Golden Staph). This bacterium can cause wound infections and Toxic Shock Syndrome, and it produces an enterotoxin which is stable to cooking and canning. The CCP for *S. aureus* is chilling during processing and storage.

Chemical hazards
Chemical hazards impacting on abalone farming and processing are:

- **Heavy metals**

Metals such as lead, cadmium, copper, arsenic etc.

- **Organic chemicals**

Agricultural residues such as organochlorine residues.

- **Antibiotics**

Oxolinic acid and oxytetracycline are administered directly or via formulated feeds. The process requires a withholding period prior to harvest and release of product and will require documentation as part of the HACCP system.

- **Anaesthetics**

Alcohol, carbon dioxide, magnesium sulphate and benzocaine are commonly used anaesthetics in removing abalone for grading. It is unlikely that anaesthetics will be used during harvest. However, if it is used, a withholding period will be required with inclusion in the HACCP system.

- **Biotoxins**

Result from Hazardous Algal Blooms (HABs), are well known in nature and can usually be seen in a body of water as a result of coastal pollution and nutrient runoff.

The significance of HABs for abalone farming became apparent during 1998-99 when paralytic shellfish poisoning (PSP) toxins were isolated from wild and farmed abalone off the west coast of South Africa (Pitcher and Calder, 2000). It is thought that a toxic dinoflagellate, *Alexandrium catenella*, entered farms in the incoming water stream. Of concern was the fact that the intoxication was not accompanied by an overt algal bloom. There has been one other report of PSP in abalone in Spain during 1991 (Martinez *et al.*, 1993). In both the Spanish and South African incident the abalone were affected by paralysis.

Paralytic shellfish poisoning (PSP) in humans results from the consumption of contaminated shellfish, usually filter-feeding molluscs which actively accumulate the toxin. The toxins, Saxitoxin and derivatives, are neurotoxins which cause symptoms similar to botulism - numbness in extremities, dizziness and listlessness. Death involves paralysis of the sympathetic nervous system resulting in respiratory paralysis. The maximum level of paralytic shellfish poisons (Saxitoxin equivalent) in bivalve molluscs is 0.8 mg/kg (ANZFA Food Standards Code).

Possible CCPs for Saxitoxin in farmed abalone include:

- Scrubbing the epithelium from the foot
- Cooking the abalone
- Instituting a withholding period.

Physical hazards

These are present in the area surrounding the processing area. The SSOPs are intended to exclude the possibility of foreign matter entering the product by:

- Covering lights with a perspex cover.
- Having stainless or impervious surfaces to prevent wood.
- Not having wire brushes or scourers which could disintegrate.

Additional precautions will be in place in the cannery HACCP system.

Risk characterisation of microbial and chemical hazards

Risk is an amalgam of:

- The likelihood of the hazard being present.
- The severity of consuming the hazard.

The dual properties of risk are considered in the HACCP worksheet of which Principle 1 requires consideration of hazards and risks.

Elements of risk analysis

Risk analysis comprises the following elements:

1. Risk assessment
    - Hazard identification
    - Exposure assessment
    - Hazard characterisation
    - Risk characterisation
2. Risk communication
3. Risk management

Definitions used in risk analysis

The definitions used are taken from the Codex Alimentarius Commission (CAC) document (Alinorm 99/13A) prepared for the joint FAO/WHO Food Standards Programme.

Dose-response assessment: the relation between the magnitude of exposure (dose) to a hazard and the severity or frequency of associated adverse health effects (response)
Exposure assessment: the evaluation of the extent of human exposure to a hazard
Hazard: a biological, chemical or physical agent in, or condition of, a food with the potential to cause an adverse health effect
Hazard characterisation: the evaluation of the nature of the health effects associated with the hazard. Note that, in a Food Safety Assessment, the concerns relate to microorganisms and/or their toxins, although other hazards are possible, e.g. chemical contaminants, foreign objects.
Hazard identification: the identification of biological, chemical or physical agent capable of causing an adverse health effect, and which may be present in a food
Quantitative risk assessment: an assessment that provides numerical expressions of risk and indication of the attendant uncertainties
Risk: a function of the probability of an adverse health effect and the magnitude of that effect, consequential to a hazard in a food
Risk analysis: a process comprising three components: risk assessment, risk management and risk communication
Risk assessment: a scientifically based process comprising the following steps: hazard identification, hazard characterisation, exposure assessment, dose-response assessment, and risk characterisation
Risk characterisation: the process of determining an estimate of the probability of occurrence and severity of known or potential adverse health effects in a given population based on the risk assessment

Risk communication: the interactive exchange of information and opinions concerning risk and risk management among risk assessors, managers, consumers and other interested parties
Risk management: the weighing of policy alternatives in the light of results of risk assessment and the selection and implementation of appropriate control options
Sensitivity analysis: a method used to examine the behaviour of a risk assessment model by measuring the variation in its outputs resulting from changes to its inputs
Transparent: characteristics of a process where the rationale, logic of development, constraints, assumptions, value judgements, decisions, limitations and uncertainties of the expressed determination are fully and systematically stated, documented and accessible for review
Uncertainty analysis: a method used to estimate the uncertainty associated with risk assessment model inputs, assumptions and structure/form

Bacterial hazards

The bacterial contaminants listed above, both indigenous and introduced during processing are all controllable within the HACCP system, specifically by appropriate chilling. Given the thermal processes used during cooking and canning, the hazards present a low level of risk as evidenced by the complete lack of reports of illness from abalone.

Heavy metals and agricultural residues

These hazards can probably be excluded from those sea-based farms and land-based farms which draw water from ocean sites due to thorough mixing with oceanic water. Evidence is provided by analysis of finfish and gastropods collected from sites near Boags Rocks in Bass Strait, near (200m and 500m) an effluent outfall from Eastern treatment Plant at Carrum, Victoria (Newell *et al*. 1999). Low levels of organochlorine pesticides, PCBs, dioxins and furans, phthalate esters and metals (Chromium, Copper, Lead and Nickel) were found in *H. rubra*.

Of relevance for abalone farms in Victoria, Fabris (2000) determined baseline contamination levels in abalone harvested from Victorian waters in Bass Strait and Port Phillip Bay. Mean metal concentrations (Table 1) were generally at least an order of magnitude lower than Maximum Permitted Concentrations (MPCs) in the Food Standards Code.

Table 1: Mean metal concentrations (mg/kg wet wt) in abalone muscle tissues

Location	Cd	Cu	Pb	Zn	Hg	Se	As (total	AS (inorganic)
Zone 1	0,10	1.9	0.05	12	0.01	0.09	6.5	0.06
Zone 2	0.18	2.1	0.05	8.3	0.01	0.12	13	0.04
Zone 3	0.04	6.3	0.05	12	0.02	0.09	2.9	0.01
MPC	2	70	0.5	150	0.5	1	na	1

Zone 1: Cape Otway to the Victorian-South Australian border
Zone 2: Cape Shank to Wilson’s promontory
Zone 3: Port Phillip Bay

The data of Fabris (2000) are relevant to at least two abalone farms within Zone 1, which draw oceanic water from Bass Strait. In Zone 2 is a sea-based farm and in Zone 3 there are several farms around Geelong. At all these farms there appears little risk of accumulating levels of metals greater than the MPC.

However, water drawn from bays, especially those surrounded by agricultural land or those in which industrial effluent is discharged, may have the potential for bioaccumulation of chemical residues. It is important that each farming operation develops information on the heavy metal status of its water column and substrates.

For farms within Port Phillip Bay, an Environmental Effects Statement (EES) commissioned by the Victorian government in connection with the proposed relocation of chemical storage from Coode Island to Point Lillias, offers information on the water and sediment quality in the immediate vicinity of several abalone farms in the Geelong area. The report (Anon., 1995) states that:

- General water quality variables such as pH, turbidity, total suspended solids and salinity were typical of coastal waters.
- Metal contamination was low in the water column.
- Organic toxicant concentrations were generally close to detection limits in the water column and were low in sediments.
- Toxicant levels were low in Pacific oysters and within MPCs in the Food Standards Code.

Several South Australian abalone farms are located at the southern end of Spencer Gulf. Little is known of the levels of metals and other toxicants in the water column or in the product, itself.

In Western Australia, an abalone farm near Albany has ocean frontage and the water column may be expected to be low in metals and toxicants.

Analysis of abalone feeds indicates little potential for incorporation of metals or agricultural chemicals. Firstly, heavy metals and residues have been shown by analysis to conform with the Food Standards Code and, secondly, most of the feed components positive for metals or residues are minor components, such as supplements.

The ANZFA Food Standards Code (March, 2000) lists maximum levels as follows:

Metal		Maximum level (mg/kg)
Arsenic	Fish	2
Cadmium	Molluscs (excluding dredge, bluff oysters and queen scallops	2
Lead	Molluscs	2

Codex Alimentarius lists the following agricultural residues and maximum levels:

	Commodity	Tissue	MRL (mg/kg)
Pirimphos-methyl	Dried fish	Muscle	3
Pyrethrins	Dried fish	Muscle	3

Antibiotics

Antibiotics are administered to abalone during growout, either directly or in the feed. Codex Alimentarius lists the following antibiotic and maximum level:

	Commodity	Tissue	MRL (mg/kg)
Oxytetracycline	Giant prawn	Not specified	100
	Fish	Muscle	100

Antibiotics, particularly oxytetracyclines and oxolinic acid, have been used in the farming sector and require control via a withholding period, plus release testing. It is believed that antibiotics are used prophylactically as a feed component by some farms which endure high (>23°C) water temperatures. It goes without saying that such use requires veterinary supervision.

Anaesthetics

Some anaesthetics (benzocaine and magnesium sulphate) have a withholding period but, providing anaesthetics are not used in harvesting for sale, it is unlikely that the withholding period will be needed.

References

Anonymous (1995) Point Lillias bulk liquid chemical storage and port facility: Cheetham baseline investigation interim report. NSR Environmental Consultants Pty Ltd, Melbourne (November, 1995).

Fabris, G. (2000) Baseline assessment of contaminant levels in four Victorian coast fish species. *Marine and Freshwater Resources Institute Report No. 24* (July, 2000).

Martinez, A., J.M. Franco, I. Bravo, M.Mazoy, and E. Cacho (1993) PSP toxicity in *Haliotis tuberculata* from N Spain In: T.J. Smayda and Y. Shimidzu (eds.) *Toxic Phytoplankton Blooms in the Sea*. Elsevier, Amsterdam. pp 419-453.

Newell, B. R. Molloy and D. Fox (1999) Environmental impact assessment and review of effluent disposal options for Eastern Treatment plant. CSIRO, Wembley, WA.

Pitcher, G.C. and D. Calder (2000) Harmful algal blooms of the southern Benguela Current: a review and appraisal of monitoring from 1989-1997. *S. Afr. J. Mar. Sci.* (in press).

Biotoxins in abalone farming: an assessment of risk

October, 2000

Contents

Risk assessment: Algal toxins in molluscs

Statement of purpose

The purpose of the present document is to assess the risk from PSPs in abalone. While there have been no documented human cases from abalone the severity of the hazard merits the assessment. The form of risk estimate will be semi-quantitative, based on a risk assessment spreadsheet.

Hazard Identification

Molluscan shellfish accumulate toxins produced by algae and other marine micro-organisms which can present significant human health risks. Shellfish generally become toxic following a Hazardous Algal Bloom (HAB) when toxigenic species reach high levels in the water. Monitoring of Australian shellfish growing areas is used to alert growers and gatherers of molluscan shellfish to the potential danger which accompanies a HAB. Outside monitoring areas, however, consumers are at risk, as evidenced by outbreaks of shellfish poisoning in NSW linked with the consumption of wild harvested "pipies" (*Plebidonax deltoides*) in 1997 and 1998 (Quaine *et al*. 1997; Hallegraeff, 1998).

There are several syndromes which arise following consumption of molluscan shellfish:

- Paralytic Shellfish Poisoning (PSP)
- Diarrhoeic Shellfish Poisoning (DSP)
- Neurotoxic Shellfish Poisoning (NSP)
- Amnesic Shellfish Poisoning (ASP)

Some HABs, while they are not toxic *per se* have disastrous effects on molluscan fisheries. In Port Phillip Bay the diatom *Rhizoselenia* cf. *chunii* bloomed in 1987, 1993 and 1994 causing loss of the commercial mussel crops because of an intense bitter flavour (Magro *et al*., 1998).

Exposure Assessment

A survey of recent literature (1993-1999) has found documented cases of shellfish poisoning in Australia only in NSW. In late 1997, 56 confirmed cases of gastrointestinal illness among 5 groups were linked with consumption of pipis (*Plebidonax deltoides*) and reported to Sydney public health units. A further 46 cases consistent with DSP were indicated but not confirmed or investigated (Quaine *et al*. 1997). This, and further cases of food poisoning in NSW linked with the consumption of wild harvested pipis in 1998 (Hallegraeff, 1998) were the stimulus for the introduction of a mandatory monitoring program. In late 1999, a recall of shellfish harvested in northern NSW was undertaken in response to the detection of elevated algal levels in the harvest area.

Approximately 5,590t of abalone were produced in Australia in 1998-99 (ABARE, 2000). During the same period 3,396t of abalone meat were exported, 1,688t chilled or frozen and 1,707t canned. Given the live:shucked ratio it is likely that >90% of abalone is consumed outside Australia. The edible weight translates to around 68,000,000 servings of 50g/serve.

Major markets for abalone are listed in Table 1.

Table 1: Abalone export destinations (1998-99)

	Chilled, frozen (t)	Canned (t)
Chinese Taipei	178	571
Hong Kong	847	456
Japan	572	328
Singapore	36	247
United States	11	56
Other	44	50
	1688	1707

Of the export destinations, three (Japan, Singapore and USA) have an enhanced food safety attitude. That is, they are likely to react quickly and decisively to any real or perceived food safety issue.

Molluscs consumed whole (oysters, pipis, mussels) represent a higher potential for intoxication than abalone because the digestive gland, the site of highest toxin concentration) is consumed. By contrast, only the foot of abalone is generally consumed, reducing the likelihood of consuming a toxic dose.

Since most/all commercial shellfish production is covered by QA programs, the hazard from non-QA shellfish is primarily from recreational gathering. A NSW fish consumption survey (Ruello, 1999) reported that 25% of households had been involved in recreational fishing in the previous three months and the average estimated total weight of fish caught in the three months preceding the survey period was 1.4 kg per fishing household. It is not possible to quantify how much of this recreational seafood consumption is shellfish.

Another survey indicates that over the period 1992-1997 recreational fishing accounts for an annual *per capita* harvest of around 128t abalone, the edible weight of which converts to about 40t (Anon., 1999).

Hazard Characterisation

Most reports have implicated several algal species as the source of contamination with *Pyrodinium bahamense* var. *compressum, Gymnodinium* sp. and *Alexandrium* sp. commonly being identified. Recent research indicates that marine bacteria may also produce these toxins (Gallacher *et al.*, 1997).

Potentially toxic dinoflagellates in Australian waters include *Alexandrium catenella* (Port Phillip Bay, South Australia, New South Wales), *A. minutum* (Port River, South Australia; Western Australia; Shoalhaven, NSW), *A. tamarense* (presumed toxic strains in Port Phillip Bay), *Gymnodinium catenatum* (Tasmania, Victoria, South Australia, New South Wales) and *Pyrodinium bahamense* var. *compressum* (potential for blooms in the Gulf of Carpentaria). Toxic *Alexandrium* in New Zealand include *A. angustitabulatum, A. catenella, A. minutum, A. ostenfeldii* (some strains toxic) and *A. tamarense* (Hallegraeff, 1998). Although mostly found in shellfish, low PSP concentrations have also been found in the gut of Victorian abalone (123 µg/100 g) and rock lobsters (Arnott, 1998).

There are about 20 toxins responsible for paralytic shellfish poisoning (PSP) all of which are derivatives of saxitoxin. Paralytic shellfish toxins are also produced by species of cyanobacteria found in Australian rivers and lakes (Humpage *et al.*, 1994; Fitzgerald *et al.*, 1999). Shellfish are not entirely immune to the effects of saxitoxins and their degree of tolerance influences their ability to feed and accumulate toxins. As a consequence species from the same affected area may accumulate different levels of toxin. Blue mussels, *Mytilus edulis*, are particularly resistant and can accumulate in excess of 20,000µg saxitoxin/100g tissue (RaLonde, 1996).

Because of their propensity to filter and accumulate particles suspended in the water column, bivalve molluscs are most at risk of accumulating toxic levels of PSP. Recently, however there have been intoxications associated with abalone. In 1991, toxin (decarbamoylsaxitoxin - deSTX) was detected in *Haliotis tuberculata* in Spain (Martinez *et al.*, 1993) resulting in closure of the fishery. In 1998-99, PSP was detected in both farmed and wild abalone (*H. midae*) on the west coast of South Africa. The toxin caused paralysis of abalone (Pitcher and Calder, 2000) and levels up to 1,600µg saxitoxin equivalent/100g tissue were determined. The rate of excretion of the PSP was slow from abalone in both Spain and South Africa, with levels >80µg saxitoxin equivalent/100g tissue present more than 7 months after onset of the incident.

The neurotoxins that cause PSP are among the most potent and can impair sensory, cerebellar, and motor functions. Saxitoxin is heat-stable and unaffected by standard cooking or steaming, is water-soluble, and can be concentrated in broth. Symptoms usually occur within 0.5-2 hours after ingestion of shellfish, depending on the amount of toxin consumed. High doses can lead to diaphragmatic paralysis, respiratory failure, and death. Predominant manifestations include paraesthesia of the mouth and extremities, ataxia, dysphagia and muscle paralysis; gastrointestinal symptoms are less common. The prognosis is favourable for patients who survive beyond 12-18 hours. In unusual cases, because of the weak hypotensive action of the toxin, death may occur from cardiovascular collapse despite respiratory support (CDC, 1991a, b).

The extreme potency of the PSP toxins has, in the past, resulted in an unusually high mortality rate. In a study of PSP in Alaska between 1973 and 1992, 54 outbreaks involving 117 ill persons were examined. Illness was not associated with the shellfish toxin level, method of food preparation, dose, race, sex, or age. Alcohol consumption was associated with a reduced risk of illness (odds ratio = 0.05; p = 0.03) (Gessner and Middaugh, 1995).

PSP toxins can be grouped into:

- Carbamate toxins (saxitoxin, neosaxitoxin, gonyautoxins 1,2,3,4)
- Sulphamate toxins (gonyautoxins 5,6; fractions C_1,C_2,C_3,C_4)
- Decarbamoyl gonyautoxins

These different PSP toxin fractions show widely different toxic potencies when injected intraperitoneally into mice, ranging from 2045 MU/μmole (saxitoxin) to 16 MU/μmole (C1), in which 1MU (mouse unit) is the amount of toxin required to kill a mouse weighing 20g in 15 minutes upon intra-peritoneal injection. In humans 120-180µg of PSP toxin can produce moderate symptoms and, while 400-1060µg can cause death, 2,000-10,000µg is more likely to constitute a fatal dose, with the body weight of the patient being an important variable.

The ANZFA Food Standards Code cites a maximum level for PSP in bivalve molluscs as 0.8mg saxitoxin equivalent/kg.

Risk Characterisation

The hazard from algal biotoxins in shellfish is influenced by the area of harvest:

- Shellfish harvested from areas with quality assurance programs
- Shellfish harvested from areas without quality assurance programs

The vast majority of commercial shellfish sold in Australia is harvested from areas with a quality assurance (QA) program that includes both surveillance for algal blooms and mechanisms so that growers do not harvest when so advised. A risk assessment of algal toxins in QA shellfish is therefore, in effect, an assessment of the likelihood of contaminated product reaching the consumer despite the QA program. A risk assessment of algal toxins in non-QA shellfish is an assessment of the likelihood of a contaminated product being consumed.

There have been no reported outbreaks of shellfish poisoning in Australia or New Zealand from QA shellfish and only sporadic reports of shellfish poisoning from non-QA shellfish e.g. 11

cases of DSP poisoning from shellfish harvested from closed areas were reported during a bloom despite public warnings (Trusewich *et al.*, 1996).

A crude estimate of the number of people in Australia consuming recreationally-caught abalone equates to about 2 million serves of 50g/serve *per annum*. It is not possible to quantify the risk from shellfish toxins associated with consuming wild harvested shellfish due to the localised nature and unpredictability of toxic algal blooms. A further consideration in the risk estimate is the species of algae present, as the severity of the illness varies widely depending on the species and toxin produced. If this number of people are regularly consuming recreational abalone in Australia, then the lack of published reports of shellfish poisoning in Australia would suggest that the risk is relatively low.

The probability of illness from PSP per annum in specific populations is calculated in Table 2 using a spreadsheet (Ross and Sumner, in preparation). The spreadsheet multiplies a series of risk criteria arranged under three category headings:

- Dose and severity
- Probability of an infective dose occurring
- Probability of exposure to an infective dose

Each year, Australia exports around 68 million servings (50g) of abalone, mainly to Asia. It is assumed that food preparation dos not significantly reduce the level of PSP. Thus, the general population of Asia might expect around 1 illness every 2 years if the contamination level were assumed to be 0.1%.

All the risk elements may be amalgamated into a Risk Ranking, with a scale of 0-100. From Table 2 it can be seen that the risk ranking for PSP in abalone contaminated at the 0.1% level to the general Asian population is 66. It should be noted that a ranking of 66 denotes relatively high risk. Using the same scheme, the risk of Hepatitis A in a coastal population in NSW is 71.

The spreadsheet is still in construction phase and details of the codings are not presented in this document. It is hoped that the model will offer a rapid means of prioritising risk and of assessing likely effects of interventions and management strategies.

Table 2: Semi-quantitative risk assessment of consumption of abalone containing PSP

Risk criteria	General Asian population
Dose and severity	
Hazard severity	Moderate - often requires medical attention
Susceptibility	General – all population
Probability of infective dose	
Probability of contamination*	0.1% contaminated
Process	Does not eliminate the hazard
Possibility of recontamination	Yes – minor recontamination
Post-process control	Well controlled
Further cooking before heating	Not effective in reducing hazard
Increase to infective dose	None
Probability of exposure	
frequency of consumption	Monthly
Proportion consuming	Some (25%)
Size of population**	1 million
Total predicted illnesses per annum in selected population	1.50E - 01
Risk ranking	40

* Assumed 0.1% contaminated
** Total servings consumed by 1 million people

Identification of Critical Data Gaps

Data on the QA programs for monitoring shellfish toxins in commercially produced shellfish would assist in quantifying the risk associated with farmed abalone. Outbreak data would be useful for estimating the risk associated with both farmed, commercially and recreationally-harvested abalone. The species of algae present in Australian waters and able to reach dangerous levels is also vital to estimation of the risk, as well as data for the volumes of abalone harvested from specific sites per day or week. Differences in the patterns of accumulation of toxins by different species of shellfish, and the levels in different tissues would also help to estimate the risk to consumers. Research to determine the causes of algal blooms could lead to new management options. The level of the harvest by recreational fishers should also be determined, as these people may be at greater risk than consumers of commercially harvested abalone because of the operation of QA program.

Critical Control Points and/or Management Options

Once toxic algae have contaminated abalone they cannot be removed by depuration or cooking (Pitcher and Calder, 2000). The toxin can persist within abalone at levels toxic for humans for weeks to months after the algae are no longer present in the growing waters. Thus, prevention of contamination, or prevention of harvest after contamination and until the toxin levels in the shellfish return to safe levels are the principal management options. Monitoring algae levels and/or algal toxin levels in shellfish are required to enact this management. Most if not all commercial shellfish fisheries already have quality assurance programs in place that include such monitoring. It is desirable to monitor all abalone fisheries, even those with no history of toxic algal blooms because blooms are unpredictable events and can affect any fishery given appropriate environmental conditions (e.g. the pipi-associated outbreak reported by Quaine *et al.*, 1997).

People who harvest wild abalone (recreational users) are at greater risk of shellfish poisoning because they are collecting from unmonitored areas. Such users should be advised of the epidemiology of paralytic shellfish poisoning to minimise their risk of illness. Some jurisdictions issue public warnings and erect signs at wild harvest areas during blooms to alert the public not to harvest or consume abalone from those areas.

References

ABARE (2000) *Australian Fisheries Statistics*, Canberra.

Anonymous (1999) *Fish Account of Australia* 1997. Australian Bureau of Statistics, Canberra.

Arnott, G. H. (1998). Toxic marine microalgae: A worldwide problem with major implications for seafood safety. *Advancing Food Safety*. 1:24-34.

CDC. (1991a). Epidemiologic notes and reports paralytic shellfish poisoning - Massachusetts and Alaska, 1990. *Morbidity and Mortality Weekly Reports*. 40(10):157-161.

CDC. (1991b). Notices to readers paralytic shellfish poisoning - Massachusetts and Alaska, 1990 errata Vol. 40, No. 10. *Morbidity and Mortality Weekly Reports*. 40(14):242.

Fitzgerald, D. J., D. A. Cunliffe, and M. D. Burch. (1999). Development of health alerts for cyanobacteria and related toxins in drinking water in South Australia. *Environmental Toxicology*. 14(1):203-209.

Gallacher, S., K. J. Flynn, J. M. Franco, E. E. Brueggemann, and H. B. Hines. (1997). Evidence for production of paralytic shellfish toxins by bacteria associated with *Alexandrium* spp (Dinophyta) in culture. *Applied and Environmental Microbiology*. 63(1):239-245.

Gessner, B. D., and J. P. Middaugh. (1995). Paralytic shellfish poisoning in Alaska: a 20-year retrospective analysis. *American Journal of Epidemiology*. 141(8):766-770.

Hallegraeff, G. M. (1998). Algal toxins in Australian and New Zealand seafood products: review of their occurrence, analytical detection and public health implications. Consultancy Report for the Australia New Zealand Food Authority (ANZFA).

Humpage, A. R., J. Rositano, A. H. Bretag, R. Brown, P. D. Baker, B. C. Nicholson, and D. A. Steffensen. (1994). Paralytic shellfish poisons from Australian cyanobacterial blooms. *Australian Journal of Marine and Freshwater Research*. 45(5):761-771.

Magro, K.L., G.H. Arnott and D..A. Hill (1997) Algal blooms in Port Phillip Bay from March 1990 to February 1995: temporal and spatial distribution and dominant species. Technical Report No. 27, Port Phillip Bay Environmental Study, CSIRO, Canberra.

Martinez, A., J.M. Franco, I. Bravo, M.Mazoy, and E. Cacho (1993) PSP toxicity in *Haliotis tuberculata* from N Spain In: T.J. Smayda and Y. Shimidzu (eds.) *Toxic Phytoplaykton Blooms in the Sea*. Elsevier, Amsterdam. pp 419-453.

Pitcher, G.C. and D. Calder (2000) Harmful algal blooms of the southern Benguela Current: a review and appraisal of monitoring from 1989-1997. *S. Afr. J. Mar. Sci.* (in press).

Quaine, J., Kraa, E., Holloway, J., White, K. McCarthy, R., Delpech, V., Trent M. and J. McAnulty. (1997). Outbreak of gastroenteritis linked to eating pipis. *NSW Public Health Bulletin*, Nov 97:103-104.

RaLonde, R. (1996). Paralytic shellfish poisoning: The Alaska problem. *Alaska's Marine Resources*. 8(2):1-7.

Ruello and Associates. (1999). Sydney Seafood Consumption Survey. Consultant’s Report.

Trusewich, B., J. Sim, P. Busby, and C. Hughes. (1996). Management of marine biotoxins in New Zealand, p. 27-30. *In* T. Yasumoto, Y. Oshima, and Y. Fukuyo (ed.), Harmful and Toxic Algal Blooms. Intergovernmental Oceanographic Commission of UNESCO.

Aussie Abs:

Standard Sanitation Operating Procedures

October, 2000

Scope of Sanitation Standard Operation Procedures (SSOPs)

Sanitation Standard Operating Procedures fall into the following categories:

- Safety of the water supply
- Condition and cleanliness of food contact surfaces.
- Prevention of cross-contamination from insanitary objects.
- Maintenance of hand washing, hand sanitising, and toilet facilities.
- Protection of food, food packaging materials, and food contact surfaces from adulteration with lubricants, fuel, pesticides, cleaning compounds, sanitising agents, condensate, and other chemical, physical, and biological contaminants.
- Proper labelling, storage, and use of toxic compounds.
- Control of employee health.
- Exclusion of pests.

1 Water supplies

Aussie Abs uses seawater drawn in a main line from 200m off the beach.

Nursery supply
Water to the nursery passes through a weed prefilter to remove large particles then through a series of sand filters (50µm). The supply is further filtered by in-line bag and cartridge filters.

Growout supply
Water to the grow-out section passes through a weed prefilter.

Effluent supply
Effluent water passes through a sand trap and into a settlement pond prior to the main exit drain back to the ocean.

Potable supply
Rain water is collected from the roof area and stored as a freshwater source. It is used for:
- Cleaning and sanitising
- Hand-washing facilities

The farm maintains three separate reticulation systems:
- Seawater
- Rain (potable) water
- Sewerage and septic tank system

Effluent is monitored by the EPA on a 3-monthly basis. The results are available in the Effluent File.

2 Condition of food contact surfaces and equipment

Requirement:

All food-contact surfaces of plant equipment and utensils are designed and constructed of material which can be cleaned and sanitised.

Currently, Aussie Abs has no processing facility for shucked abalone.

3 Cross-contamination

Requirement:

Prevention of cross-contamination from insanitary objects to food, food-packaging material, and other food contact surfaces, including utensils, gloves, and outer garments, and from raw material to cooked product.

Hand wash basins, soap dispensers and single-use towel dispensers are situated in the amenities.

Adequate, readily accessible toilet facilities that provide for proper sewage disposal are available and maintained in a sanitary condition and in good repair. Toilet facilities are cleaned and soap dispensers and paper towel dispensers are refilled as necessary.

4 Protection from adulteration

Requirement:

Protection of food, food-packaging material, and food-contact surfaces from adulteration with lubricants, fuel, pesticides, cleaning compounds, sanitising agents, anaesthetics, and other chemical, physical, and biological contaminants.

Chemicals (lubricants, detergents, sanitisers, pesticides) are stored away from the processing area while not being used.
Pesticides are not allowed in the processing area. They are only used on the outside perimeter.
Fluorescent light tubes and light bulbs in the packing area are covered with perspex.

5 Toxic Chemicals – labelling, storage and use

Requirement:

Proper labelling, storage, and use of toxic compounds.

Toxic compounds shall be identified, held, used, and stored in a manner that protects against contamination of food, food- contact surfaces, or food-packaging materials.

All these chemicals are stored in the workshop.
For storage, the chemicals are held in their original containers. The manufacturers' labels identify the containers.
Anaesthetics are stored in a locked cupboard with access only to prescribed personnel (see job descriptions in Process manual)
The Manager holds Material Safety Data Sheets (MSDS) and Directions for Use (DFU's) for each of the chemicals used by the staff.

6 Employee Health

Requirement:

Control of employee health conditions that could result in the microbiological contamination of food, food-packaging materials, and food-contact surfaces.

Any person who, by medical examination or supervisory observation, is shown to have, or appears to have, an illness, open lesion (including boils, sores, or infected wounds), or any other sources of microbiological contamination by which there is a reasonable possibility that food, food-contact surfaces, or food packaging materials will become contaminated, shall be excluded from any operations that may be expected to result in such contamination until the condition is corrected.

Staff understand that must report the following to their Manager:

- Stomach illness
- Cold, influenza – sneezing, coughing
- Sores, boils or infected wounds
- Drowziness after using anaesthetics

7 Pest Control

Requirement:

Exclusion of pests from the production area. No pests are in any area of a food plant.

While Aussie Abs considers spraying and bait stations useful, we prefer preventative measures such as hygiene, good storage conditions and tidiness as the main pest control methods.

Aussie Abs

Process Control Manual

October, 2000

Contents

1 MANAGEMENT COMMITMENT TO THE HACCP SYSTEM

1.1 COMPANY DECLARATION

Aussie Abs has hatchery, nursery and growout operations for the production of abalone. The company processes live abalone for domestic and export consumption and for further processing by a contract packer.

This document details how we undertake the various operations which comprise our business.

Our quality system comprises three parts:

- Work procedures.
- Standard Sanitary Operating Procedures (SSOPs).
- Hazard Analysis Critical Control Point (HACCP) analysis.

These aspects are covered in three manuals which detail how we meet requirements of Australian and overseas controlling authorities.

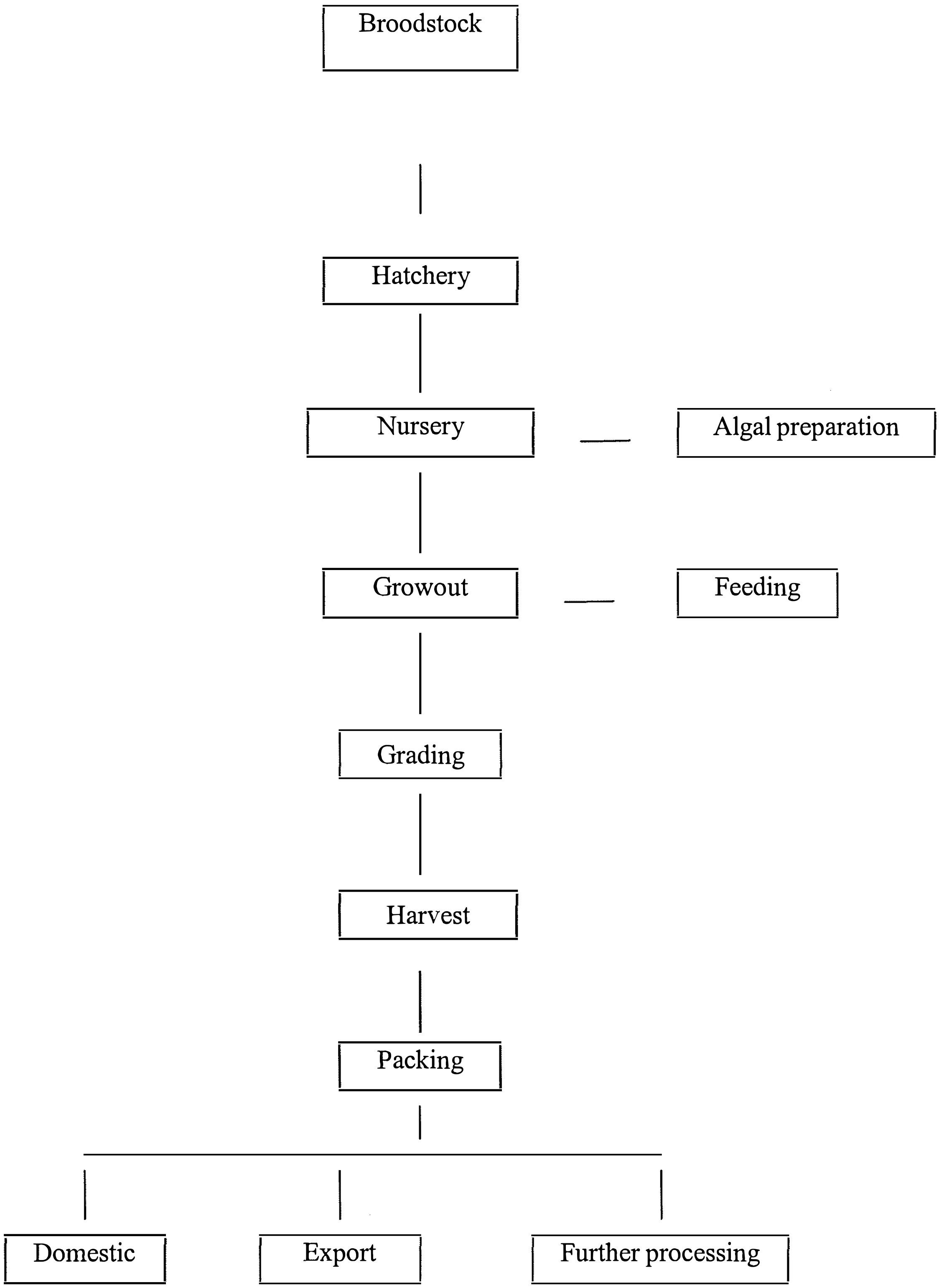
Controlling authorities and customers may access our quality system and its verification at any time.

Accordingly, I, Frank Farina make this commitment on behalf of my company.

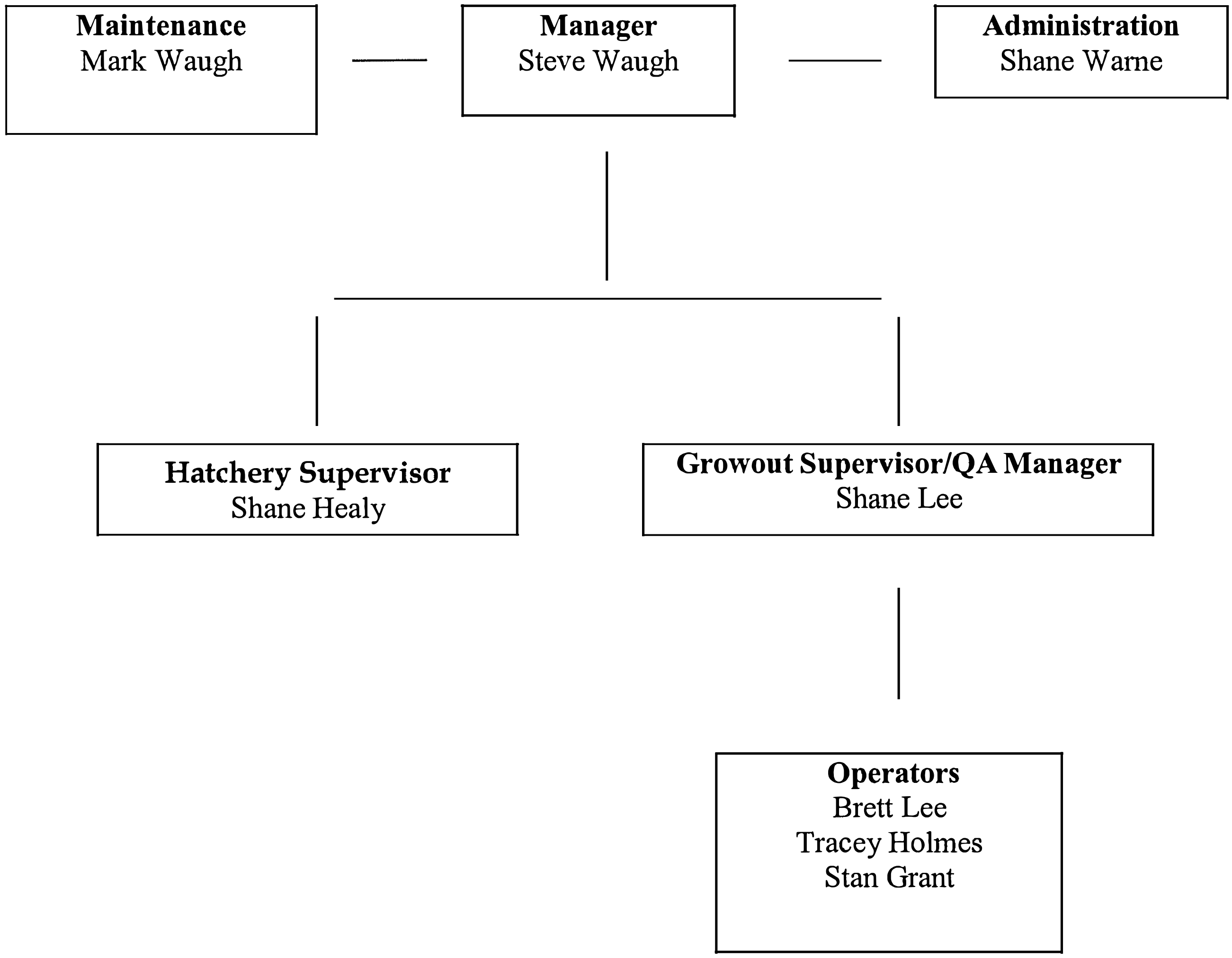
....

Signed Date
Frank Farina
(Manager)

1.1.1 Aussie Abs: Operations flow



ORGANISATION



1.2 JOB DESCRIPTIONS OF PERSONNEL INVOLVED WITH HACCP SYSTEM

1.2.1 Manager

The roles and responsibilities to the QA system are:

1. Overall responsibility for the system and its operation.
2. Sign the QA plan on behalf of the company.
3. Be responsible for authorising Corrective Actions.

1.2.2 Hatchery supervisor

The supervisor is responsible for:
1. Operating the hatchery and nursery.

1.2.3 Growout supervisor/QA Manager

The Growout Supervisor/QA Manager is responsible for:
- i) Informing the Manager of any problems with the system as written.
- ii) Day-to-day operation of the QA system.
- iii) Monitoring and maintaining the QA system.
- iv) Administration of anaesthetics and ensuring adherence to withholding period prior to harvest.
- v) Administering algal event alerts from the Controlling Authority.

1.2.4 Operators

The operators are responsible for:

- Feeding abalone during growout.
- Cleaning the growout system.
- Anaesthetising and grading of abalone during growout under supervision
- Harvesting of abalone

1.2.5 Maintenance

Maintenance staff are responsible for:
1. Ensuring supplies of potable freshwater and a safe working environment are available at all times.

2 HATCHERY OPERATIONS

2.1 PROCUREMENT AND MAINTENANCE OF BROODSTOCK

2.1.1 Mature abalone intended for broodstock are obtained either from the wild or selected from domesticated stock on site.

2.1.2 Abalone are sexed and segregated into holding tanks.

2.2 SPAWNING

2.2.1 Seawater temperature is raised above ambient.

2.2.2 Seawater is passed through ultraviolet light.

2.2.3 Abalone are sometimes placed in a polybox for 0.5-1h.

2.2.4 Fish are replaced in tanks where spawning occurs.

2.2.5 The viability of sperm is checked microscopically.

2.3 FERTILISATION

2.3.1 Eggs are siphoned through a filter (200-400µm) into a container.

2.3.2 Sperm are added to egg water (ca 5-10,000 sperm/mL of egg water).

2.3.3 Eggs and sperm are allowed 10-15 minutes mixing for fertilisation to occur.

2.3.4 Eggs being fertilised settle on the container floor.

2.3.5 Excess sperm is rinsed from the eggs through water changes.

2.4 HATCHING OF LARVAE

2.4.1 Fertilised eggs are placed in larval tank.

2.4.2 Larvae hatch at 16-18°C.

2.4.3 Larvae are scooped to a new tank for 1-2 days when shell and operculum are developed.

2.4.4 The water level is dropped and larvae filtered onto a 70-100µm mesh.

2.4.5 Larvae are transferred to a new larval tank which has been cleaned and sanitised.

2.5 LARVAL DEVELOPMENT

2.5.1 After a 5-6 day period larvae cease swimming and settle on the base of the tank.

2.5.2 The third tentacle develops.

2.5.3 Larvae are transferred to the nursery.

3 NURSERY OPERATIONS

3.1 FEED SET UP

3.1.1 PVC plates are placed in baskets in the nursery tanks.

A bag filter is placed over inflow to tank.

3.1.2 Feed algae (*Nitzchia* and *Navicula*) attach to plates and multiply.

3.1.3 Algal build up occurs for 2-3 weeks.

3.2 LARVAL TRANSFER

3.2.1 About one million larvae are added to each nursery tank.

3.2.2 Water flow is reduced for 24h to assist attachment to plates (settling).

3.2.3 A banjo sieve is placed over the tank outflow to prevent loss of larvae.

3.3 NURSERY GROWTH

3.3.1 Water flow is gradually brought back to normal to prevent build up of bacteria.

3.3.2 Settling occurs on plates.

3.3.3 Some plates are transferred to a new tank (splitting out) after 6-8 weeks when abalone reach 2-3mm.

3.3.4 Fresh plates containing copious algal growth are interspersed among plates bearing fish.

3.3.5 Fertilisers such as urea and sodium metasilicate are added to the tanks to promote algal growth.

3.3.6 After 4-5 months, when fish reach 6-8 mm at a density of 75-100/plate they are moved to growout.

4 GROWOUT OPERATIONS

4.1 GROWOUT SYSTEM

4.1.1 Abalone are grown in darkness in variety of systems:

- Tanks arranged in tiers through which water constantly flows from top to bottom.
- Closed pipes through which water constantly surges.
- Round tanks in which water vortexes into a central exit.
- Large raceways which are self-cleaning.

4.2 FEEDING

4.2.1 Abalone are fed particulate feeds every other day.

4.2.2 Feed hydrates and swells allowing grazing by the abalone.

4.3 CLEANING

4.3.1 Trays are cleaned every other day by brushing excreta into the water stream where it leaves the growout sheds in the exit stream.

4.3.2 Closed pipes are cleaned by the surge of water.

4.3.3 Round tanks are cleaned by brushing detritus into the exit vortex.

4.3.4 Large raceways are self-cleaned by periodic surges.

4.4 GRADING

4.4.1 Grading is carried out during the growing period to prevent over population in the tanks.

4.4.2 The initial fish population is approximately 2500/tank at the 8mm stage.

4.4.3 The first grading occurs after 6-8 months when the abalone are 15-20mm.

4.4.4 Three ranges are graded: 15-20mm, 20-25mm, >25mm.

4.4.5 Fish are anaesthetised prior to grading.

4.4.6 A second grading after a further 8 months is made in the ranges: <30mm, 30-40mm, >40mm.

4.4.7 A third grading after a further 8 months is made at <40mm, 40-50mm, >50mm.

4.4.8 A final grading after a further 8 months is undertaken to remove undersize abalone for further growout.

5 HARVESTING AND PACKAGING

5.1 SELECTION OF MARKETABLE FISH

5.1.1 Marketable fish are arranged in tiers for loadout or taken directly from the tanks and packed into polystyrene boxes for transfer to the processing facility.

5.1.2 Fish are purged for 5 days.

5.2 PACKING FOR DOMESTIC TRANSPORT

5.2.1 A polybox is arranged with foam at the base and an ice pack at the side.

5.2.2 Into an inner plastic bag is inserted the foam and four layers of core flute with spacers between them.

5.2.3 Fish are arranged on the 4 layers to give a total weight of 10kg.

5.2.4 The box is sealed.

5.3 PACKING FOR EXPORT

5.3.1 The temperature is reduced over a 2-day period to 12°C.

5.3.2 Steps 5.2.1 - 5.2.3 (above) are carried out).

5.3.3 The polybag is inflated with oxygen and sealed with a rubber ring.

5.3.4 An icepack is placed at the side of the bag.

5.3.5 The box is sealed and transported to the airport.

6 FEED STORAGE AND HANDLING

Feed has a shelflife around 6 months (low lipid content).
Feed is received as:

- Crumb in 25kg bags with plastic liners.
- Small chip in 1t bags
- Big chip in 1t bags

Feed from bulk bags is transferred to silos and withdrawn as necessary for *ad lib* feeding.
Feed in the small bags are stored off ground on a rodent proof pallet and transferred to smaller silos as necessary.

Form 1: Monitoring of administration of chemicals to marketable abalone

Algal events

Date when alert from Controlling Authority received ………………

Date action undertaken

“Do not harvest” signs placed on all tanks of mature abalone ………………

All staff alerted to potential danger of harvest ………………

Date when alert is ended by Controlling Authority ………………

Date withholding period ended and “Do not harvest” signs removed ………………

Comments:

Signed ……………………………..

Form 2: Administration of antibiotics

Antibiotic	Dose	Tanks treated (date)	“Do not harvest” signs posted (date)	Withholding period (date)	Release testing confirmed (date)	“Do not harvest” signs removed (date)

Aussie Abs

HACCP plan

October, 2000

CONTENTS

Step 1: Form HACCP team

Aussie Abs HACCP team comprises:

Frank Farina	(Manager)
Steve Waugh	(Hatchery Supervisor)
Shane Warne	(Growout Supervisor)

Step 2: Description of each product type, process type and packaging format

The following products are covered by this HACCP plan:

Greenlip abalone (*Haliotis laevigata*)

Blacklip abalone (*Haliotis rubra*)

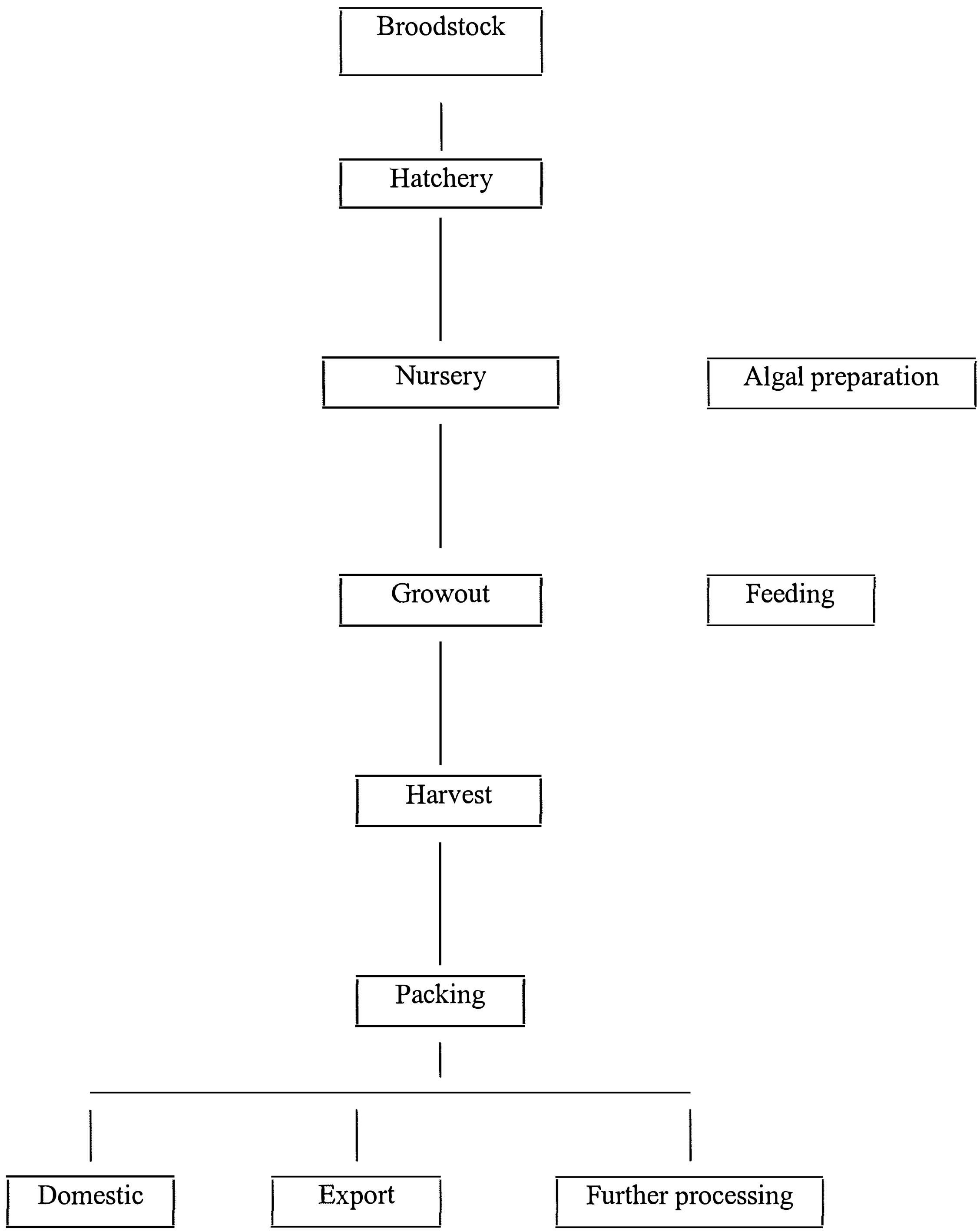
Product is processed live and packed in polyboxes for transport either for further processing or for restaurant sale.

Step 3: Intended use of each product

The foot will be consumed only after cooking although it is recognised that in a very small number of cases the entire abalone may be consumed raw.

Step 4: Process flow diagram: Farming, harvest and loadout of abalone

Aussie Abs: Operations flow



Step 5: Verify the flow diagram
The HACCP team has verified the process flow diagram.

Step 6: Identify all hazards
Potential hazards for abalone farming are presented below:

1. Biological hazards

None

2. Chemical hazards

- Anaesthetics
- Antibiotics

If antibiotics and anaesthetics are not administered during the final stages of growout then they cease to be hazards.

- Heavy metals
- Agricultural chemical residues

In the case of Aussie Abs neither heavy metals nor agricultural chemical residues are considered as hazards due to site selection in open coastal water.

- Biotoxins

3. Physical hazards

None

Step 7: Determine Critical Control Points (CCPs)
We have adopted the Codex Alimentarius definition of a CCP: *"A step, process or element which prevents, eliminates or reduces a hazard to an acceptable level"*.

It is our aim to reduce the number of CCPs by using prerequisite programs eg Sanitation Standard Operating Procedures (SSOPs). Process steps at which hazards are introduced are listed in the Hazard Control Worksheet, together with their CCPs.

Step 8: Establish Critical Limits for each CCP
At each CCP we have established critical limits, outside of which the CCP is deemed not in control.

Step 9: Set up a monitoring and checking system at each CCP

Our checking and monitoring system for abalone raising and packout is based on the following format. Each monitoring regime is detailed in the HACCP Plan Form.

Operation	What	Who	How	When

Step 10: Establish Corrective Actions

We have two approaches to Corrective Action:

1. Stabilise the immediate problem.
2. Review our HACCP system and incorporate changes to ensure no recurrence of the problem.

Corrective Actions are detailed in the HACCP Plan Form.

Step 11: Establish a verification system

We verify our HACCP system as follows:

1. On a weekly basis where the Manager is responsible for reviewing the QA records and passing on information for the monthly managerial meeting.
2. Following any significant alteration to a process or packout format.
3. Internal audit.

Step 12: Maintain records

Our records are maintained in a series of files which are Controlled Documents and are identified in the Process Control Manual.

Hazard Control Worksheet: abalone

Process step	Type of hazard	Cause of hazard	Significance of hazard			Control Measure
			Severity of hazard	Likelihood of hazard occurring	Significance of hazard	
Step 1: Hatchery	BIOLOGICAL None CHEMICAL None PHYSICAL None					
Step 2: Nursery	BIOLOGICAL None CHEMICAL None PHYSICAL None					
Step 3: Feeding	BIOLOGICAL None CHEMICAL Biotoxins Antibiotics PHYSICAL None	Hazardous Algal Bloom in farm water Antibiotic treatment of marketable abalone	High	Low	High	CCP 1: Appropriate withholding period Testing of product before release Conformance with Food Standards Code
Step 4: Packout	BIOLOGICAL CHEMICAL None PHYSICAL None					

HACCP chart: Abalone farming and packout

Critical Control Point (CCP)	Significant Hazards	Critical Limits for each Preventive Measure	Monitoring				Corrective Action	Records	Verification
			What	How	Frequency	Who			
CCP 1: Withholding period	Antibiotic residues	Maximum Residue Limit (MRL) as in Food Standards Code (FSC)	Withholding period	Document period before harvest Confirm by testing prior to release	End of period	Manager	Mark all tanks, races with "DO NOT HARVEST" signage	Form 2	Test results from laboratory
	Biotoxins	No more than 80mg/kg Saxitoxin equivalent	Withholding period	Document period before harvest Confirm by testing prior to release	Until level complies with FSC	Manager	Mark all tanks, races with "DO NOT HARVEST" signage	Form 1	Test results from laboratory

Aussie Abs Pty Ltd

Standard Sanitation Operating Procedures for the shelling and processing of abalone

October, 2000

Sanitation Standard Operating Procedures (SSOP’s)

Sanitation Standard Operating Procedures fall into the following categories:

i) Safety of the water supply
ii) Condition and cleanliness of food contact surfaces.
iii) Prevention of cross-contamination from insanitary objects.
iv) Maintenance of hand washing, hand sanitising, and toilet facilities.

Protection of food, food packaging materials, and food contact surfaces from adulteration with lubricants, fuel, pesticides, cleaning compounds, sanitising agents, condensate, and other chemical, physical, and biological contaminants.

v) Proper labelling, storage, and use of toxic compounds.
vi) Control of employee health.
vii) Exclusion of pests.

1 Water supplies

Aussie Abs Pty Ltd uses two sources of water in the processing of abalone:

- Clean, filtered seawater
- Potable water

Seawater is used for washing abalone prior to shelling. It drawn in a main line through a weed prefilter to remove large particles then through sand filters. The supply is further filtered by in-line bag and cartridge filters.

Potable (treated) water derived from rain water.

Potable water is used for:

- Cleaning and sanitising
- Hand-washing

The factory maintains three separate reticulation systems:

- Seawater
- Potable water
- Sewerage and septic tank system

2 Condition of food contact surfaces and equipment

Requirement:

All food-contact surfaces of plant equipment and utensils are designed and constructed of material which can be cleaned and sanitised.

2.1 Construction

The following provisions have been made in the design of the factory and facilities and equipment to support cleaning and sanitation:

1. Tables and work surfaces are constructed of stainless steel.
2. Any joins or other surface joins are smooth to avoid the build up of food and subsequent bacterial growth, and to assist in cleaning. The surfaces are maintained free of cracks, cuts, etc.
3. Slurry and ice tanks are all plastic and bins are all plastic construction. Cracked bins are removed from the processing area.

4. Cleaning & Sanitation

Chemicals

General purpose detergent for scrubbing equipment, utensils including knives, food containers, bench-tops, and walls and floors.

Sanitiser – broad action sanitiser, sodium hypochlorite, for general sanitising of all surfaces.

Equipment

Sponges, scourers and buckets for manual cleaning.

Cleaning and sanitation chemicals are based on:

General purpose detergent for hand washing of food containers and utensils

Sodium hypochlorite sanitiser for general sanitising of all surfaces and food-baths

General Cleaning Regime:

After each processing day:

i) Dry clean to remove rubbish

ii) Apply detergent to wet soil and dirt particles for easy removal.

iii) Rinse with potable water

iv) Apply sanitiser

v) Rinse off and dry before commencement of work

Monitoring:

The Harvest Supervisor monitors the cleandown and also arranges for working surfaces to be cleaned if needed prior to processing.

2.3 Maintenance

Aussie Abs has maintenance staff on site and also uses local contractors to service electrical equipment, refrigeration and who check plant and equipment for serviceability. The Harvest Supervisor does a weekly inspection of the plant and equipment and marks off anything needing attention on the Maintenance Check Sheet (Form 4). Any other personnel noticing a defect in plant or equipment will report the matter to the Harvest Supervisor who will arrange to fix the defects.

3 Cross-contamination

Requirement:

Prevention of cross-contamination from insanitary objects to food, food-packaging material, and other food contact surfaces, including utensils, gloves, and outer garments.

3.1 Process separation

The process is separated according to:

Receival of abalone

Washing of in-shell product

Processing of abalone

Shelling

Separation of non-edible portions

Packing

Holding prior to loadout

These areas are spatially separated.

Receival and washing are carried out outside the packing area which takes place in a facility which has been constructed for the processing of edible product.

Hand wash basins, soap dispensers and single-use towel dispensers are situated in the processing area. The hand wash basins are foot-operated to prevent recontamination of washed hands

The Harvest Supervisor checks before processing that soap dispensers and hand towel dispensers are adequately filled or organises to top them up.

3.2 Process Regimes

Staff are required to wear clean outer garments.

If staff drop any utensils on the floor, they must be washed before using again.

3.3 Staff Training

Staff personal hygiene requirements are explained to new staff.

Signs are placed at strategic points stating that hands must be washed after toilet visits and before returning to work stations.

Employees must:

1. Wash hands with the hand sanitizing solutions supplied in the detergent dispensers situated in the toilets and at the entrances to the factory.
2. Wear clean outer clothes.
3. Not wear loose jewelry in the factory

Checks are performed by the Harvest Supervisor before production on the employee dress standards and hygiene and corrective action taken before start-up.

3.4 Toilet Facilities

Toilet facilities are cleaned daily with bleach (sodium hypochlorite). Soap dispensers and paper towel dispensers are refilled. Rubbish bins are emptied.

4 Protection from adulteration

Requirement:

Protection of food, food-packaging material, and food-contact surfaces from adulteration with lubricants, fuel, pesticides, cleaning compounds, sanitising agents, condensate, and other chemical, physical, an biological contaminants.

Chemicals (lubricants, detergents, sanitisers, pesticides) are stored in the workshop, away from the processing area while not being used.

Fluorescent light tubes and light bulbs in the packing area are covered with perspex.

5 Toxic Chemicals – labelling, storage and use

Requirement:

Proper labelling, storage, and use of toxic compounds.

Toxic compounds shall be identified, held, used, and stored in a manner that protects against contamination of food, food- contact surfaces, or food-packaging materials.

Aussie Abs hold certification from the supplier of cleaning chemicals, anaesthetics, pest control service contractor and lubricant supplier that the chemicals supplied or used are internationally approved for use in food processing plants.

Anaesthetics are stored in a locked cupboard and used only under supervision of the supervisor.

All these chemicals are stored in a designated area in the workshop.

Chemical store is a separate room located away from any food preparation or storage, and away from packaging and machinery storage– used for detergents.

Plant room – used for refrigerant gas bottles, lubricants

The pest control contractor provides a service report for each service stating what pesticides were used for the service. Pesticides are not held on-site. The contractor who brings them to the site for treatment holds them off-site. They are not brought into the plant sections where food is exposed.

For storage, the chemicals are held in their original containers. The manufacturers' labels identify the containers.

The Harvest Supervisor holds Material Safety Data Sheets (MSDS) and Directions for Use (DFU's) for each of the chemicals used by the staff.

6 Employee Health

Requirement:

Control of employee health conditions that could result in the microbiological contamination of food, food-packaging materials, and food-contact surfaces.

Any person who, by medical examination or supervisory observation, is shown to have, or appears to have, an illness, open lesion (including boils, sores, or infected wounds), or any other sources of microbiological contamination by which there is a reasonable possibility that food, food-contact surfaces, or food packaging materials will become contaminated, shall be excluded from any operations that may be expected to result in such contamination until the condition is corrected.

Staff understand that they have a responsibility to report to their supervisor if they have the following:

- stomach illness
- cold, influenza – sneezing, coughing
- any sores, boils or infected wounds
- drowziness after using anaesthetics

The Supervisor will decide whether this may be a potential source of contamination and may decide to remove the employee from the line, or if appropriate cover a wound with an impervious dressing.

The Supervisor will remove anyone from the line if that person is ill.

7 Pest Control

Requirement:

Exclusion of pests from the food plant. No pests are in any area of a food plant.

While Aussie Abs considers spraying and bait stations useful, we prefer preventative measures such as hygiene, good storage conditions and tidiness as the main pest control methods.

We contract a pest control company to, as necessary:

- Spray the external perimeter of the processing area and carton store for cockroaches and spiders
- Set and inspect rodent baits, replacing baits if any signs of activity

Residual surface spray is not allowed within the processing area.

Aussie Abs Pty Ltd

Process Control Manual for processing of abalone for canning and live distribution

October, 2000

Contents

2 MANAGEMENT COMMITMENT TO THE HACCP SYSTEM

6.1 COMPANY DECLARATION

Aussie Abs Pty Ltd has hatchery, nursery and growout operations for the production of abalone. The company processes live abalone for domestic consumption and shelled, chilled muscle for further processing by a contract packer.

This document details how we undertake the various operations which comprise our business.

Our quality system comprises three parts:

- Work procedures.
- Standard Sanitary Operating Procedures (SSOPs).
- Hazard Analysis Critical Control Point (HACCP) analysis.

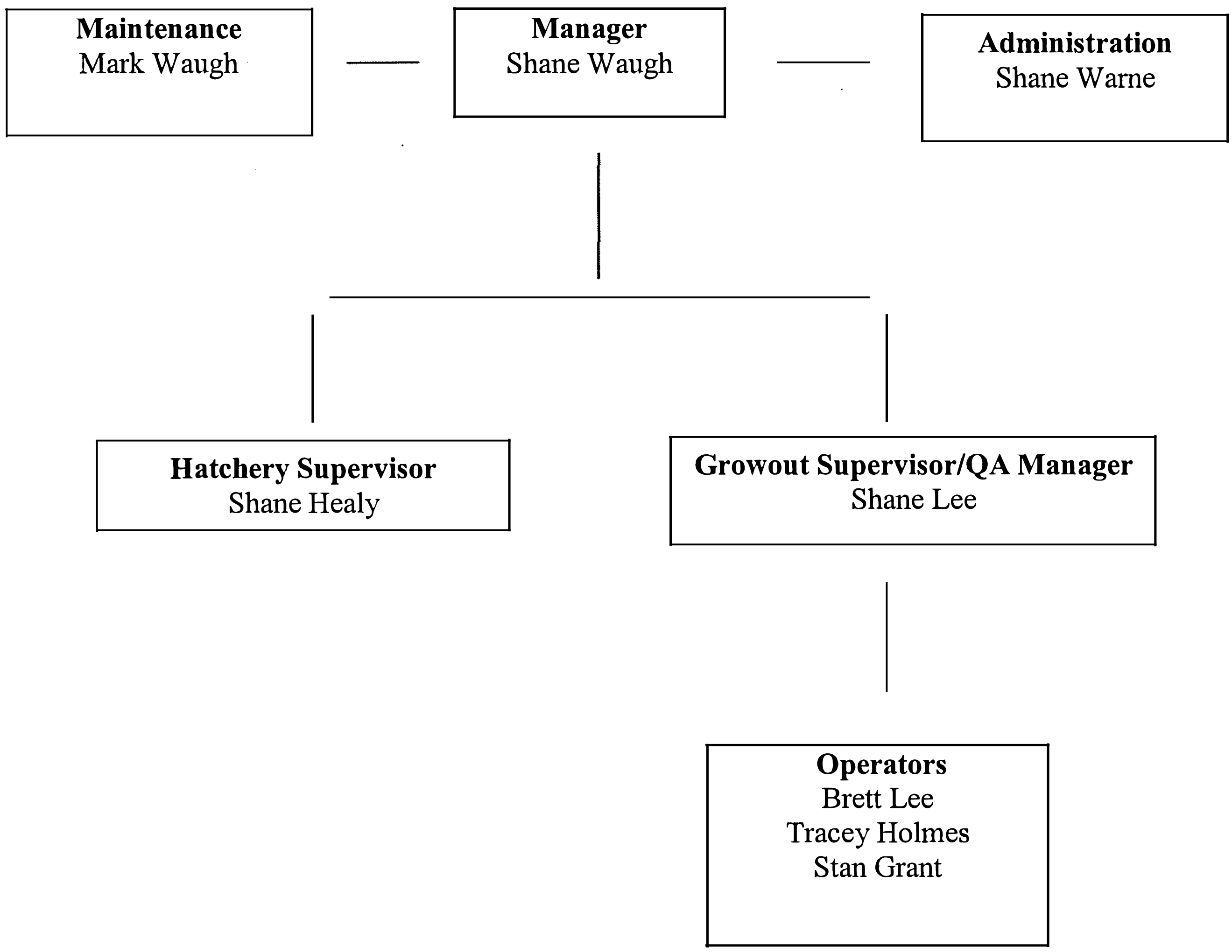
These aspects are covered in three manuals which detail how we meet requirements of Australian and overseas controlling authorities.

Controlling authorities and customers may access our quality system and its verification at any time.

Accordingly, I, Frank Farina make this commitment on behalf of my company.

....
Signed Date
Frank Farina
(Production Manager)

6.2 ORGANISATION



JOB DESCRIPTIONS OF PERSONNEL INVOLVED WITH HACCP SYSTEM

6.2.1 Managing Director

The roles and responsibilities to the QA system are:

4. Overall responsibility for the system and its operation.
5. Sign the QA plan on behalf of the company.

6.2.2 Production Manager

The Manager is responsible for:

2. Overseeing the operating the hatchery and nursery.
3. Authorising Corrective Actions.

6.2.3 Hatchery Supervisor

The Hatchery Supervisor is responsible for:

1. Informing the Manager of any problems with the system as written.
2. Day-to-day operation of the QA system.
3. Monitoring and maintaining the QA system.
4. Supervising harvest, processing and transport of abalone

6.2.4 Operators

The Operators are responsible for:

vi) Shucking, cleaning and packing abalone.
vii) Cleaning of premises.

7 PROCESSING FOR CANNING

7.1 SELECTION OF STOCK

7.1.1 Abalone are selected according to size >75mm for canning

7.1.2 Each piece is checked with a marker.

7.2 REMOVAL OF ABALONE

7.2.1 Each abalone is removed with knife.

7.3 WEIGHING

7.3.1 Abalone are weighed in batches.

7.4 HOLDING

7.4.1 Batches are held in a seawater tank until required.

7.5 PROCESSING

7.5.1 Abalone are transferred from holding tank to shelling table.

7.5.2 The shell is removed with a rounded paint scraper and stored in bags for sale.

7.5.3 The gut is removed and stored in bags for disposal off-site.

7.5.4 Meat is placed in bins for bleeding then transferred to a holding tank.

7.5.5 Meat is drained for ca 10 min in drainage crates.

7.5.6 Meat is placed in a plastic bag.

7.5.7 Bags are placed in seawater/ice slurry for chilling.

7.5.8 Chilled product is removed to fish bins, surrounded by ice.

7.5.9 Bins are lidded and stored in a chiller until loadout.

7.5.10 Bins are loaded and the temperature recorded on the QA sheet.

7.5.11 Product is transported to the cannery.

8 PROCESSING FOR LIVE SALE

8.1 SELECTION OF STOCK

8.1.1 Abalone are selected according to size for live sale.

8.1.2 Each piece is checked with a marker.

8.2 REMOVAL OF ABALONE

8.2.1 Each abalone is removed with knife.

8.3 HOLDING

8.3.1 Abalone are placed on fluteboard trays each of which is located in a mesh crate which is lidded.

8.3.2 Crates are placed in a holding tank for a minimum of 24 hours for purging.

8.3.3 In summer, the holding tank is gradually cooled to 5C below ambient over a period around 16 hours.

8.4 PACKING

8.4.1 Providing they are torpid, abalone are transferred from holding tank to the packing room.

8.4.2 An ice gel and absorbent pad are placed at opposite corners of an insulated box.

8.4.3 A plastic liner bag is placed into the insulated box.

8.4.4 Three trays of abalone are placed in the box, separated by foam supports and foam sheets.

8.4.5 The liner is filled with oxygen and closed.

8.4.6 A gel pack is placed on a foam sheet in the top of the box.

8.4.7 The box is lidded and taped.

8.4.8 The box is weighed, labelled and the consignment note attached.

8.4.9 The consignment is transported to the airport for air freight.

AUSSIE ABS

Form 3: Monitoring of abalone processing

Processing date ………………………….

Pre-processing check

Handwash station has soap and paper towels	YES/NO
Premises and working surfaces are clean	YES/NO
Staff are properly clad	YES/NO
Toilets are clean	YES/NO

Process control

Ice maintained in seawater slurry	YES/NO
Ice present in transport bins	YES/NO

Post process check

Premises satisfactorily cleaned	YES/NO

Comments

Signed …………………………………….

(Harvest supervisor)

AUSSIE ABS

Form 4: Maintenance check sheet

Date	Request for maintenance	Date fixed

Aussie Abs Pty Ltd

HACCP plan

October, 2000

Contents

Step 1: Form HACCP team

Aussie Abs Pty Ltd HACCP team comprises:

Steve Waugh (Production Manager)

Mark Waugh (Harvest Supervisor)

Step 2: Description of each product type, process type and packaging format

The following products are covered by this HACCP plan:

Greenlip abalone (*Haliotis laevigata*)

Blacklip abalone (*Haliotis rubra*)

Product is shelled and the abalone meat chilled and packed in polyboxes for transport for canning.

Live abalone in polyboxes are transported to the restaurant trade.

Step 3: Intended use of each product

The product will be consumed only after thermal processing, either canning or cooking, which will kill all pathogens which may reasonably be expected to contaminate the product.

Step 4: Process flow diagram: harvest, packing and loadout of abalone

Harvest

Weigh

Hold in tank

Shell removal

Bleed meat in bins

Drain

Chill in ice slurry

Pack in polybag

Bags packed in bins with ice

Store in cold room until transport

Transport to cannery

Step 5: Verify the flow diagram

The HACCP team has verified the process flow diagram with an on-site inspection.

Step 6: Identify all hazards

Potential hazards for abalone are presented below:

4. **Biological hazards**

Pathogenic bacteria

- *Clostridium botulinum*
- *Vibrio parahaemolyticus*
- *Staphylococcus aureus*
- *Aeromonas hydrophila*
- *Listeria monocytogenes*

5. **Chemical hazards**

- Biotoxins
- Antibiotics

These elements are covered by the HACCP plan for raising of abalone. Abalone with a likelihood of contamination with any of the above chemical hazards will not be harvested.

6. **Physical hazards**

Foreign matter

Step 7: Determine Critical Control Points (CCPs)

We have adopted the Codex Alimentarius definition of a CCP: *"A step, process or element which prevents, eliminates or reduces a hazard to an acceptable level"*.

It is our aim to reduce the number of CCPs by using prerequisite programs eg Standard Sanitation Operating Procedures (SSOPs). Process steps at which hazards are introduced are listed in the Hazard Control Worksheet, together with their CCPs.

Step 8: Establish Critical Limits for each CCP

At each CCP we have established critical limits, outside of which the CCP is deemed not in control.

Step 9: Set up a monitoring and checking system at each CCP

Our checking and monitoring system for abalone raising and packout is based on the following format.

Operation	What	Who	How	When

Each monitoring regime is detailed in the HACCP Plan Form

Step 10: Establish Corrective Actions

We have two approaches to Corrective Action:

3. Stabilise the immediate problem.
4. Review our HACCP system and incorporate changes to ensure no recurrence of the problem.

Corrective Actions are detailed in the HACCP Plan Form.

Step 11: Establish a verification system

We verify our HACCP system as follows:

4. On a weekly basis where the Harvest Supervisor is responsible for reviewing the QA records and passing on information for the monthly managerial meeting.
5. Following any significant alteration to a process or packout format.
6. Internal audit.

Step 12: Maintain records

Our records are maintained in a series of files which are located in the office.

Hazard Control Worksheet: abalone farming and transport

Process step	Type of hazard	Cause of hazard	Significance of hazard			Control Measure
			Severity of hazard	Likelihood of hazard occurring	Significance of hazard	
Step 1: Harvest	BIOLOGICAL Pathogenic bacteria	*C. botulinum* *V. parahaemolyticus* Organisms naturally present in sea water	High Low	Low High	High Low	CCP 1: Chilled storage during processing CCP 2: Chilled storage during transport CCP also exists at cannery or caterer: Thermal process during canning or cooking
	CHEMICAL Biotoxins Antibiotics	Hazardous Algal Blooms Antibiotic use during growout	High Low	Low Low	High Low	CCP: Monitoring for algal events and antibiotic use Withdrawal period before harvest Release testing at laboratory This CCP is part of the farming HACCP plan
	PHYSICAL None					
Step 2: Weighing in shell	BIOLOGICAL None CHEMICAL None PHYSICAL None					
Step 3: Holding	BIOLOGICAL None CHEMICAL					

until shelling	None					
	PHYSICAL					
	None					
	BIOLOGICAL	*S. aureus* from handlers	Low	High	Low	CCPs 1 and 2
	Pathogenic bacteria	*Listeria monocytogenes* and *Aeromonas hydrophila* from environment	High	High	High	CCPs 1 and 2
Step 4: Shelling, bleeding	CHEMICAL					
	None					
	PHYSICAL	Metal, glass	High	Low	High	Controlled by SSOPs (construction of processing premises)
	Foreign matter					
	BIOLOGICAL					Chilling phase represents CCP 1
	None					
Step 5: Packing	CHEMICAL					
	None					
	PHYSICAL					Packaging stored in secure surroundings
	None					
	BIOLOGICAL					
	None					
Step 6: Chilling in ice slurry	CHEMICAL					
	None					
	PHYSICAL					
	None					

Step 7: Chilled transport	BIOLOGICAL None CHEMICAL None PHYSICAL None	Chilled transport phase represents CCP 2

HACCP chart: Abalone processing, chilling and transport

Critical Control Point (CCP)	Significant Hazards	Critical Limits for each Preventive Measure	Monitoring				Corrective Action	Records	Verification
			What	How	Frequency	Who			
CCP 1: Chilling	Pathogenic bacteria	Product no warmer than 3.3C	Ice present in seawater slurry	Visual	Constant	Operator	Add ice to slurry	Form 3	Weekly by Harvest Supervisor
CCP 2: Chilled transport	Pathogenic bacteria	Product no warmer than 3.3C	Ice present in storage bins through journey	Visual	Constant	Receival operator	Check temperature and chill immediately. Inform Hatchery Supervisor	Form 3	Weekly by Harvest Supervisor