

# Report on the SafetyNet Snow Crab Occupational Asthma Study

for

The Working Group on Shellfish Asthma



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**Please Note: These research findings are still preliminary in that they have not yet been published in peer reviewed journals. In addition, given the exploratory nature of the research and development activities undertaken as part of this project, Memorial University makes no representations or undertakings related to the quality or nature of the research work other than that such work will be performed in good faith and with the best efforts of those participating.**

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## Executive Summary

Asthma is a respiratory condition that results in episodic breathing difficulties. These occur when the airways constrict, become inflamed and/or swollen and fill with mucus. Occupational asthma due to snow crab is a specific type of work-related asthma associated with processing snow crab. Crab asthma is caused by overexposure to the airborne materials that are generated when cooking, steaming, washing, sawing, crushing, scrubbing or scraping crab in processing plants.

This report summarizes results to date from SafetyNet's three-year, interdisciplinary study on occupational asthma to snow crab in Newfoundland and Labrador. The snow crab industry is a major contributor to the regional economy and to employment and incomes in more than 40 rural Newfoundland and Labrador communities. The relative importance of snow crab to the economies of many rural communities and the number of processing employees have increased substantially in the past decade. This report discusses the history of the industry, employment trends and the research objectives of the study as a whole. It outlines the research methodologies, summarizes findings to date from each component of the study and provides some recommendations for future research and actions related to occupational asthma to snow crab in Newfoundland and Labrador.

Members of the Working Group need to be aware that participation in this study by plants was on the understanding that the identity and location of participating plants would be kept confidential by the researchers. In addition, participation in study components by individual workers, managers and health professionals was voluntary and on the basis that confidentiality and anonymity would be preserved.

The crab asthma project had several major components:

- self-administered questionnaires on beliefs and concerns about the health effects of working with crab among management, workers and health professionals administered at the start and the end of the research;
- training sessions with health professionals related to the diagnosis and treatment of asthma and occupational asthma;
- air sampling to quantify allergen concentrations in various areas of the participating plants and compare concentrations between plants with different layouts, processing systems and ventilation systems;
- comparisons of allergen concentrations associated with processing crab prior to cooking (raw) and processing cooked crab;
- air flow modeling in work environments including modeling modified technology designs intended to reduce allergen exposures;
- chemical research on the composition of aerosolized proteins associated with crab processing;
- immunological research comparing reactivity of proteins in raw and cooked crab to the sera of sensitized participants;

## Shellfish Asthma Working Group Report, May, 2004 Short Version

- comparisons of the prevalence of allergy and occupational asthma to snow crab in the four participating plants and identifying risk factors for the development of these conditions;
- research on the quality of life and social and economic impacts of allergy and occupational asthma to snow crab in the study communities.

In general, the findings to date from the crab asthma study strongly suggest that the prevalence of snow crab asthma varies across plants with different histories and processes but that overall, it is likely to be disturbingly high across the industry, particularly in older plants with poor ventilation. Ventilation and enclosure processes appear to be inadequate in many plants; technologies and processes have not been designed and tested to ensure they minimize aerosolization of allergens; inadequate diagnostic services and the economic vulnerability of workers in the industry have contributed to under-reporting, to substantial risk of persistent respiratory problems away from crab for some workers, and, too often, to poor management of asthma. As a result, sensitized workers and their families have experienced significant health, quality of life and financial costs. An effective program of prevention, diagnosis, treatment and compensation for the industry is long overdue and will be costly and difficult to achieve. This situation, the location of plants in vulnerable single industry communities with few employment alternatives, the challenges of diagnosing snow crab OA, low incomes, declining quotas and other threats to the industry, the high cost of retraining and limited programs currently available to support economic diversification all point to the need for interagency collaboration and special initiatives to address this serious problem.

The Recommendations section of this report contains 64 recommendations. Recommendations refer to initiatives designed to promote primary, secondary and tertiary prevention of snow crab asthma and its health and socio-economic impacts. The recommendations are further organized into subcategories on the basis of the group or agency with responsibility for the action identified. They include some recommendations for further research.

A member of the Working Group referred to this as a relatively small study. It is a small study; the first of its kind in the province. Not surprisingly there is more work to be done. However, this project has already achieved positive benefit not only with respect to expanding the knowledge base (both scientific, on the part of the investigators, and pragmatic, on the part of the crab workers and health professionals involved), but in terms of definitive changes at the plant process level in two of the plants. As well, it was possible to assess the ventilation system that has been installed in Plant 1, to conclude that the design engineers had done an excellent job, and provided a "text-book" well-conceived system.

### Summary of Findings to Date

In our original proposal, we proposed to study *five* Newfoundland and Labrador plants with differing histories of involvement in snow crab processing. Our intent was to try to approximate a representative sample of the industry and of the general crab processing

## Shellfish Asthma Working Group Report, May, 2004 Short Version

labour force as a basis for the development of a provincial prevalence estimate of the incidence of allergy and OA to snow crab. In the end, we were able to sign memoranda of understanding with “representative” plants from only four of the five categories. We were not able to find a representative large (>10 million pounds/year), old (15-30 years of crab processing) plant willing to participate in the study.

### **Beliefs and Concerns Questionnaires (Start and End of Research)**

In 2002, workers, management and health professionals were asked to complete a self-administered questionnaire at sector-level meetings at the start of the research (in 2002) and in individual appointments and sector-level meetings towards the end (in 2003). These questionnaire results provide an indication of the level of knowledge, awareness and concerns about the health effects of processing crab in participating communities before and after the research. In 2002, 65% indicated that they associated specific problems with crab processing workers; 70% in 2003. The most common problems identified for both administration dates were cough, back pain and chest tightness. In both 2002 and 2003, 86% of the respondents said that they had heard of crab asthma. About half of these people said they had heard about it through a coworker. On both administration dates, most respondents correctly identified the common symptoms associated with crab asthma as difficulty breathing, chest tightness, and cough. In 2002, a relatively high number of respondents said they did not know if asthma medication is addictive. In 2002, 54% said they did not know if a blue puffer is all that is needed to treat crab asthma and almost half of the respondents said they did not know if workers with crab asthma are eligible for worker’s compensation. In 2003, more respondents knew a blue puffer was not enough to treat crab asthma, more respondents knew crab asthma is compensable and more knew that asthma can be very serious. In 2002, over half of the health professionals indicated they did not know if crab asthma was compensable, but 80% knew this in 2003. In 2002, almost all of the health care professionals felt they did not have the training needed to diagnose crab asthma, and half said they did not have access to the services and tools needed to confirm a diagnosis of crab asthma. Few health professionals completed the questionnaire in 2003 making it impossible to compare responses between the two administrations.

### **Snow crab aeroallergen concentrations within the processing environment**

We collected and analyzed a total of 237 allergen samples for this study. Of these samples, 108 were low volume or personal breathing zone (pbz) samples (3-4 litres per minute [lpm]) and 129 were high volume or area samples (120-150 lpm). These samples indicated that overall, allergen concentrations were higher in Plants 2 and 4 than in the other two plants and that allergen concentrations were not obviously linked to the volume of crab processed. High allergen concentrations were particularly associated with the activities of cooking and mechanical cleaning and sawing of cooked crab. Generally, activities involving the manipulation of cooked crab were associated with higher allergen levels than those associated with the manipulation of raw crab.

**Shellfish Asthma Working Group Report, May, 2004**  
**Short Version**

**Ventilation and Air Flow Analysis**

While all four plants had taken some steps to hood, vent and/or enclose their cooking areas, the effectiveness of these systems for containing allergens in the steam varied from plant to plant. Less common were systems of ventilation and enclosure designed to minimize allergen exposures related to other activities such as the butchering, cleaning and sawing of crab. Three of the four study plants had little or no ventilation in their main processing areas and in two of these plants in particular, these areas were associated with high allergen concentrations. We have modeled air flows associated with different hooding and ventilation systems with a particular focus on mechanical cleaning and sawing areas. This analysis should be useful to engineering firms interested in providing advice on the design of enclosure and ventilation systems for these activities.

We have received a copy of a ventilation design produced by the IRSST in Quebec for the crab processing industry. This design was intended to help minimize exposure to allergens from cooking-related steam. This document has been translated into English and forwarded to the Working Group. It has also been posted on the SafetyNet website <http://www.safetynet.mun.ca>.

**Allergen identification for raw crab, cooked crab and cooking water**

Tropomyosin is an easily identified protein in air samples and samples of crab meat and crab cooking water from the crab plants (Whiteway, 2003). Immunoblot studies suggest that sensitized workers react to tropomyosin but also to several other crab proteins. There is some overlap in the allergenic proteins found in cooked and raw crab but there are also some differences. Some workers appear to be reactive only to raw crab, some only to cooked crab, and some to both. Our study suggests that crab proteins are both heat-labile and heat-stabile.

**Prevalence**

Based on the combined results from medical questionnaires, prick skin tests, blood tests and, where available, peak expiratory flow monitoring we were able to arrive at six possible diagnoses for both occupational allergy and snow crab occupational asthma:

- almost certain
- highly probable
- possible
- unlikely
- negative/probably negative, and
- no diagnosis due to missing information.

Those with a diagnosis of “almost certain OA” had a medical history of symptoms of asthma during the season, improving after leaving work, a positive skin test or RAST (to determine the presence in the sera of the workers of IgE antibodies directed against crab allergens) indicating allergy to snow crab, and positive peak flow monitoring. Those with

**Shellfish Asthma Working Group Report, May, 2004**  
**Short Version**

a diagnosis of “highly probable OA” would have had a positive medical history of symptoms of asthma during the season improving after leaving work and either a positive PFM at work but negative skin test or RAST or a positive skin test or RAST to snow crab extracts but either no PFM data at work or negative/dubious/unreliable PFM.

Those with a “possible” diagnosis would have had a positive medical history, negative RAST or skin test and either no PFM data at work or negative/inadequate PFM. Those with a diagnosis of “unlikely or negative OA” would have had no history of asthma symptoms at work that improved after leaving work, could have had a negative or positive skin test or RAST and no PFM data or negative PFM.

Overall, 16.3% of 215 participants had an “almost certain” or “highly probable” diagnosis of snow crab OA, and 22.3% a diagnosis of possible snow crab OA. The percentage of study participants diagnosed as “almost certain” or “highly probable” ranged from a high of 47% to a low of 8% across the four plants. The percentage of study participants diagnosed as “possible” snow crab OA ranged from a high of 27% to a low of 11% across the four plants. For the related problem of occupational allergy to snow crab, defined as rhinitis (runny nose), conjunctivitis (red or runny eyes) or rash, an average of 17% overall were diagnosed as “highly probable” occupational allergy. These percentages varied between a high of 42% and a low of 9% across the four plants.

For most participants, the diagnosis of crab asthma or allergy relies mainly on history and confirmation of sensitization to crab as evaluated by skin tests or RAST; monitoring of PEF was available and useful in only a minority of the subjects. It is thus likely that some workers with positive skin tests or RAST and a positive history, for whom PFM was not done or inconclusive, do not have occupational asthma even if they had a highly probable diagnosis. Similarly, some workers with negative skin test and RAST to snow crab might have positive Peak Flows if these were done. In a study done in two snow crab processing plants in Îles de la Madeleine in Quebec, Cartier and co-workers (Cartier A et al., 1986) found that the positive predictive value of skin tests and RAST to snow crab allergens were respectively 76% and 89% meaning that 24 and 11% of subjects could be falsely diagnosed as having occupational asthma based on skin tests or RAST. Alternatively, the negative predictive value of skin tests and RAST were 69 and 54% meaning that subjects with negative skin tests or RAST would be wrongly diagnosed as not having occupational asthma in 31 and 46% of the cases. Skin tests and RAST are therefore better at confirming than excluding occupational asthma.

Care needs to be taken generalizing from these results to the labour force in these plants and, more generally, to the industry as a whole because of the relatively low participation rates in the study plants. Participation in this study component was voluntary and dependent on our ability to contact potential participants and their availability and willingness to participate in the tests. Participation rates, i.e. the percentage of the current and former workers we attempted to contact and who agreed to an appointment, varied across plants from somewhat less than half of the current and former workers in three plants up to 52% in the fourth one. The extent to which participants were representative of the larger labour forces in the plants in terms of age, gender and seniority varied from

## Shellfish Asthma Working Group Report, May, 2004 Short Version

plant to plant. However, even if all those workers who were not evaluated had no evidence of crab asthma or occupational allergy, the prevalence of these would still be very high.

Analysis of risk factors associated with the development of work-related symptoms revealed that atopy, i.e. the propensity to develop allergy to common allergens, is a risk factor for developing occupational asthma. The vast majority of workers are smokers and, in this sample of workers, smoking was not a risk factor to develop occupational asthma to crab but was associated with an increased risk for developing occupational allergy symptoms (rhinitis, conjunctivitis or rash). The lack of association of smoking with the development of occupational asthma may be due to the small number of workers (20%, n=44) who were non-smokers.

In this study, women are more likely to have an almost certain/highly probable diagnosis of snow crab occupational asthma than men. This appears to be due to gender differences in work history. A comparison of the work histories for men and women study participants showed that, on average, women had worked longer with crab (mean 4.9 years; median 5; range 1 month to 10 years) than men (mean 3.5 years; median 4; range one month to 10 years). In addition, the gender division of labour tends to concentrate women on jobs such as packing and cleaning associated with higher allergen levels and higher risk (66% female/34% male) but this varies somewhat from plant to plant. Men are more likely to work as butchers (89% male/11% female) and on outside jobs (79% male/28% female) where exposures are lower.

### **Cumulative Exposures**

For this part of the study, allergen sampling results were used to divide the plant into 'zones' with different average allergen levels. A zone represented one or more working areas. While completing the medical history questionnaire, participants listed up to three main jobs that they performed while working at the plant and indicated how many seasons they spent at each. This information was used to determine the areas of the plants in which the participants had worked and the period of time spent in each area. Estimated cumulative exposures were calculated by multiplying the estimated zone exposure level (i.e. the average exposure from each area sampled in a zone) by the number of weeks spent in that zone for each of the three jobs listed. The result is a value that encompasses both the length of time exposed and exposure levels for each participant.

Preliminary analysis of the cumulative exposure data indicates that median cumulative exposures differ significantly by gender for our study participants ( $p=0.001$ ) where women (C.E. =  $4390.4 \text{ ng/m}^3 \times \text{weeks}$ ) have a much higher median cumulative exposure than men (C.E. =  $2684 \text{ ng/m}^3 \times \text{weeks}$ ). The median cumulative exposure for participants who received a diagnosis of 'highly probable' OA was significantly higher than that for those with a diagnosis of possible OA. Similarly, the median cumulative exposure for those with a diagnosis of possible OA was significantly higher than that for those with a diagnosis of unlikely/negative.

Shellfish Asthma Working Group Report, May, 2004  
Short Version

**Peak Flow Monitoring (PFM) and Compliance**

All study participants were asked to complete PFM and a high percentage of participants in all plants agreed to do so. However, many of those who agreed to complete PFM did not send in their diary cards. This was particularly true for the return to work component of the study. Of those participants who completed their PFM, less than 20% had PFM results suggestive of Occupational Asthma suggesting that those with occupational asthma were not more likely to complete their peak flows. Poor compliance with this test for confirming the presence or absence of crab asthma means, however, that we were unable to objectively confirm the presence or absence of crab asthma for most study participants. To address the poor return rates, all participants who came to return appointments were given a second opportunity to complete PFM. Many people, once again, failed to complete both pre- and post-diary cards.

**Quality of Life and Socio-Economic Impacts**

All thirty-eight participants who came to follow up appointments and who reported symptoms of occupational asthma or allergy to snow crab were asked to stay behind at the end of their appointment for the quality of life and socio-economic component. All agreed. They were asked to complete a general health survey called the SF12-v2 and, depending on their symptoms, they were also asked to complete one or two quality of life (QOL) surveys, the Dermatology Life Quality Index (DLQI) and the Asthma Quality of Life Questionnaire (AQLQ). Because participants were away from work during the first set of interviews, the three surveys were re-administered via phone interview after they returned to work the following spring via phone interview. All who participated in this component were also asked to participate in a semi-structured interview about the socio-economic and quality of life (QOL) impacts of their symptoms.

The SF12-v2 questionnaire was used to assess the general health of the workers. Statistical analysis of results from the second administration of the SF12-v2 produced significantly lower scores than those on the first administration for two of the eight health concepts: bodily pain and mental health. This suggests that these participants may have experienced a decline in their general health after returning to work.

The Asthma Quality of Life Questionnaire (AQLQ) requires the respondent to volunteer up to five activities that are personally important and that they can no longer do or cannot do as well because of asthma symptoms. On the first administration of this survey, about six months after participants had finished work at the plant, 16 of the 26 workers who completed the questionnaire volunteered activity limitations. The most commonly reported activities were walking upstairs, going for a walk and hurrying. A comparison of the scores from the first and second administration of the questionnaire revealed that the identified activities were significantly more limited when they were at work as opposed to away from work. On average, the scores on the second administration, after the respondent had returned to work, were lower suggesting that the participants' quality of life was better when they were away from work.



## Shellfish Asthma Working Group Report, May, 2004 Short Version

The DLQI was administered to only a small number of participants (13) during the return appointments and to an even smaller number of participants (9) during the follow-up phone interviews. There were no significant differences between the two administrations of the questionnaire.

Several themes emerged from the interviews with symptomatic workers suggesting significant life quality impacts related to crab asthma and allergy to crab. None of those interviewed had been told by their employers when they began working at the plant about occupational asthma as a health risk associated with processing snow crab. All respondents reported using medication for their symptoms and most reported visiting the hospital or clinic to seek medical attention for their symptoms. Respondents from all four plants complained that the continuous turnover in doctors and nurses led them to be discontented with the care they've received. Participants resist leaving their jobs at the plant because they need the income and because of the lack of job alternatives in their communities. Most participants admitted to finding ways to stay at work, despite feeling ill, because they needed the hours in order to be eligible for Employment Insurance during the winter.

### **Ongoing Research**

We carried out an experiment comparing allergen aerosolization associated with raw versus cooked processing on May 26<sup>th</sup> and 27<sup>th</sup>, 2004. At that time, we also sampled for proteins and transferred the expertise associated with collecting and analyzing protein samples from the IRSST in Quebec to Dr. Helleur's lab in Chemistry at Memorial. The protein sampling will permit us to compare protein and allergen sampling and explore the feasibility of using protein sampling as a proxy for allergen levels in the future. Protein samples will also be used to try to develop a means to quantify protein levels. Finally, during this experiment, we sampled for endotoxins in the air and in the cooking water. Results from the different parts of this experiment should be available by the end of June, 2004 and will be sent to the Working Group at that time.

## Recommendations

### Primary Prevention

Primary prevention means preventing a disease such as occupational asthma. For occupational diseases like occupational asthma, primary prevention is key because once workers are sensitized, their options and the options of employers are much more constrained. At present, there is no effective, coordinated primary prevention regime for crab asthma in place in the province. Such a regime needs to be developed and implemented as soon as possible to minimize the risk that more workers will be sensitized. This will require actions on the part of a number of organizations including the Department of Fisheries and Aquaculture, crab processing equipment designers and manufacturers, agencies that fund research and development in the industry, employers, Occupational Health and Safety (OHS) Committees and the Department of Human Resources, Labour and Employment. Further research is also required to confirm and monitor the effectiveness of primary prevention initiatives identified to date after they are implemented.

### Primary Prevention-related Recommendations for the Department of Fisheries and Aquaculture

The Department of Fisheries and Aquaculture is responsible for licensing snow crab plants in Newfoundland and Labrador. Ideally, plants should not have been given licenses to process snow crab without clear evidence that steps had been taken to minimize snow crab allergen exposures. Unfortunately, there was no mechanism in place to ensure this would happen and we now have 40 licensed plants in the province. The current state of excess capacity in the snow crab processing industry in Newfoundland and Labrador and recent quota cuts are contributing to seasonality, worker vulnerability to unemployment and employer unwillingness to invest in plant infrastructure. Vulnerability to unemployment appears to be an important disincentive to report this occupational disease.

We therefore recommend that the Working Group consider:

1. recommending to the Department of Fisheries and Aquaculture that no new licenses for snow crab processing be issued until the burden of occupational crab allergy and asthma can be mitigated.
2. recommending that the Department of Human Resources, Labour and Employment carry out a full inventory of crab processing plants in the province documenting the nature and extent of systems for preventing the aerosolization of allergens, enclosure and, where possible, point source removal of aerosolized allergens. Based on the results of this inventory, plants with documented shortcomings related to ventilation and enclosure should be asked to submit proposals for upgrading their

**Shellfish Asthma Working Group Report, May, 2004**  
**Short Version**

plants to improve ventilation, lower allergen levels, enclose allergens at source and, where environmental controls are not possible, for the introduction of personal respiratory devices. These proposals should also include a reasonable timeline for upgrading. If companies fail to carry out the changes in a timely fashion, the Department of Fisheries and Aquaculture should consider revoking their crab processing licences.

**Primary Prevention-related Recommendations for Crab Processing Equipment and Ventilation System Designers and Suppliers**

Minimizing the aerosolization of proteins, enclosing and separately venting areas where allergens are aerosolized or, where this is not possible, hooding and ducting allergens away from workers are the essential elements of primary prevention. This study suggests that, in some cases, processing technology design is contributing to allergen exposures in crab processing plants and, that current technologies are not designed in such a way as to facilitate the enclosure and ventilation of allergen producing processes like mechanical cleaning and sawing.

Given that under the Occupational Health and Safety Act, an **equipment supplier** is expected to “ensure, where it is reasonably practicable for him or her to do so, that tools, appliances or equipment that he or she supplies is in safe operating condition,” and given that under the regulations it is stipulated that ventilation shall be used to control worker exposures, we recommend that

3. crab processing equipment suppliers review equipment designs to identify ways to reduce allergen aerosolization and where this is not feasible ensure that practical features of containment and exhaust are incorporated with this equipment. These measures must effectively remove contaminants and must not impede worker access.

**Primary Prevention-related Recommendations for Public Agencies that Support Research, Development and Training in the Crab Industry**

Given that publicly funded agencies sometimes support the development of new technologies and production processes in the crab processing sector, we recommend that

4. agencies that have supported the design of crab processing technologies in the past financially contribute to efforts to adapt current technologies so as to minimize exposures and that they subject all future technology design proposals and experiments to a health impact assessment prior to funding the proposal and release of the project design to industry.
5. the Marine Institute review its curriculum for courses related to seafood processing to ensure that these contain full and adequate modules related to the OHS risks of seafood processing and ways to minimize these risks.

**Primary Prevention-related Recommendations for Employers**

The findings of this comparative study of four snow crab processing communities point to the presence of high allergen levels and the absence of effective enclosure and separate venting of some allergen-generating processes in most of these plants. Department of Human Resources, Labour and Employment research on plant ventilation and enclosure systems done in 2000 suggests that these problems may be widespread in the industry. All plants included in this study had taken some steps to minimize exposures over the past several years, primarily with a focus on enclosing and venting allergens aerosolized in steam from the cooking process. These initiatives were consistent with practices in Quebec and their effectiveness varied from plant to plant. Previous research focused on the steam from the cooking process as the major factor contributing to allergen exposures making this the primary focus of prevention initiatives. Our research suggests that other processes like cleaning and sawing, particularly of cooked crab, are also very important sources of aerosolized allergens. Identifying ways to reduce allergen aerosolization from these processes and containment and venting of those that are aerosolized in a cost effective fashion should be a priority for employers and the Department of Human Resources, Labour and Employment.

In light of the findings of this research and given that, under the province's Occupational Health and Safety Act, employers have a general duty to ensure "where it is reasonably practicable, the health, safety and welfare of his or her workers", we recommend that employers

6. abide by, and regulatory authorities enforce, the existing specific legal requirements that under section 11 of the OHS Regulations, subsections 2 and 3 according to which (2) An employer whose work or process gives off dust or fume or another impurity of a kind and quantity liable to be injurious or offensive to workers, shall provide, maintain and ensure the proper use of a ventilation system sufficient to protect the workers against inhalation of impurities and to prevent it accumulating in a workplace. (3) Wherever practicable, local exhaust ventilation shall be installed and maintained near to the point of origin of the impurity to effectively prevent it entering the air of the workplace."
7. undertake this work in accordance with fundamental principles and accepted practices of industrial ventilation , namely, that
  - a. contaminant release be limited through process / product selection
  - b. contaminant emission be controlled by containment, and mechanical local exhaust of dominant sources
  - c. make-up air be provided in a manner such that it is supplied in the least contaminated area(s) occupied by workers, passes the source of contaminant and is exhausted so as not to pass through the breathing zone

**Shellfish Asthma Working Group Report, May, 2004**  
**Short Version**

of any other workers; this should not be achieved by means of open windows and/or doorways, but may be effected by the considered installation of passive louvres

Ensure that the configuration and operation of exhaust stack(s) is such as to discharge the air away from the building envelope, precluding re-entrainment and/or direct exposure of ground-level personnel. In addition, employers should

8. adhere to a regularly scheduled preventive maintenance program. All components of the ventilation systems, cookers, crushers, and other related items should be properly maintained. Develop suitable maintenance plans complete with records to ensure that the required maintenance activities are undertaken routinely and the ventilation equipment is effective for control of air quality.
9. re-assess their ventilation systems, equipment enclosures systems including hoods and all related ductwork when renovating the plant, changing production processes, or changing the volume of production.
10. send written notice to the Assistant Deputy Minister of any proposed new plants as per Section 5.3 of the OHS Regulations before construction takes place. In the case of renovations, employers should consult with an Industrial Hygienist at the Department of Labor at the design stage to ensure that the renovations are adequate.

**Primary Prevention-related Recommendations for the Department of Human Resources, Labour and Employment**

The Department of Human Resources, Labour and Employment is responsible for administering the OHS Act and for the maintenance of reasonable standards for the protection of OHS in Newfoundland and Labrador workplaces. Under the OHS Act, 65.(1) “The Lieutenant-Governor in Council may make regulations (b) setting out the health and safety standards to be established at workplaces or classes of workplace; ... (g) establishing conditions as to the design, construction and use of a plant or undertaking in order to protect the health and safety of workers; ... (n) requiring the making of arrangements by employers for the prevention of industrial disease and for securing the health of workers, including arrangements for medical examinations and health surveys; (o) requiring the making of arrangements by employers for monitoring the atmospheric or other conditions of workplaces; (o.1) requiring an employer to identify, assess, and minimize the risk of a prescribed injury or disease to workers.”

Given the substantial risk to OHS entailed in crab asthma and its potential consequences for workers, given that many of the ventilation and technology design changes required to reduce allergen exposures are probably similar across plants, and in order to help contain costs to individual companies, reduce duplication of effort and improve the likelihood that suggested changes will be effective, we recommend that

**Shellfish Asthma Working Group Report, May, 2004**  
**Short Version**

11. the Department of Human Resources, Labour and Employment, perhaps in partnership with other agencies such as the Centre for Fisheries Innovation and drawing on research findings to date, do a full review of all of the crab plants in the province with a focus on production processes, ventilation and related enclosure systems. It should then fund a professional industrial engineer to design generic ventilation/enclosure systems appropriate for different types of crab plants, production processes and technologies that could be adapted for particular plants. The Working Group on Shellfish Asthma and the Canadian Food Inspection Agency should monitor this research and provide advice to the engineer.
12. when designs become available, they be submitted for publication to the American Industrial Hygiene Association's (ACGIH) most recent edition of *Industrial Ventilation: a Manual of Recommended Practice*. This is a reference source used by many industrial hygienists.

And that

13. the Department of Human Resources, Labour and Employment develop regulations or standards for minimal ventilation and for the enclosure and separate venting of production processes known to generate substantial allergen levels.

Until a permissible exposure limit becomes available through the ACGIH, we recommend the Working Group consider asking the Department of Human Resources, Labour and Employment to adopt

14. a permissible exposure limit for crab allergen of 100 ng/m<sup>3</sup> from pbz samplers. We have identified plants in Quebec and in Newfoundland where concentrations are already well below 100 ng/ m<sup>3</sup> suggesting that this is an achievable goal. While it is true that some workers who are already sensitized may react to lower concentrations (i.e. <100 ng/m<sup>3</sup>) it seems most prudent to recommend target concentrations which are achievable and most likely to prevent or minimize sensitization. If the maximum is set at 100, there will be many areas in the plants with substantially lower levels where sensitized workers could be relocated, although this will have to be accompanied by close monitoring of the individuals. Levels in all areas may still be too high for highly sensitized individuals.

In order to develop a fuller understanding of allergen exposures in Newfoundland and Labrador plants, the factors responsible for such exposures, and the effectiveness of interventions carried out by plant owners, we recommend

15. the Department of Human Resources, Labour and Employment recommend that all plants carry out allergen sampling and repeat this sampling whenever changes occur in the processing procedures, layout, etc.

**Shellfish Asthma Working Group Report, May, 2004**  
**Short Version**

In plants determined by the Department to lack adequate ventilation and enclosure systems or where occupational health and safety committees report respiratory problems among workers, we recommend

16. provincial hygienists require employers to sample for allergens and present the results to the Department. The Department could facilitate this process by counseling private consultants on the appropriate sampling and analytical techniques once it has validated the method used to measure workplace exposures.

With current allergen sampling analysis techniques, small quantities of human sera from sensitized workers need to be accessed. Because the proteins to which workers are reacting are somewhat different in raw and cooked crab, we recommend that, in the short term at least,

17. allergen samples should be analysed using sera from workers sensitized to both raw and cooked crab to see if this results in different allergen levels.

We also recommend that

18. provincial hygienists conduct allergen sampling in a broader range of snow crab processing plants than were available to this study. Air sampling during meat production should be treated as a priority because we don't yet have data on the levels associated with this production process.
19. wherever possible, the results from such allergen sampling, as well as allergen sample results from sampling carried out by companies be linked to production processes, production levels, etc. in a systematic fashion and these values be reported to the Committee on Industrial Ventilation for the American Conference of Governmental Industrial Hygienists (ACGIH) and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) for use in refining recommendations for the design, maintenance and evaluation of ventilation systems including , enclosure and containment methods and the technology and process design for the crab processing industry as a whole both in this Province and elsewhere .

Given that workers in some plants maintain that respiratory problems tend to be exacerbated during boilover events, we recommend that

20. employers be required to install devices to prevent boilovers and to contain water and steam associated with boilovers (such as the device in use in Quebec and described in this executive summary).

We recommend that the Department of Human Resources, Labour and Employment, with help from other groups,

**Shellfish Asthma Working Group Report, May, 2004**  
**Short Version**

21. take steps to identify funds to test the effectiveness of alternative personal protection devices for preventing exposure to crab allergens. Until such tests are done workers should be advised that no tests have been performed to verify the effectiveness of the respirator(s) under the conditions found in crab plants. This would ensure that workers don't have a false sense of security (i.e. believe they are protected when they may not be).

We recommend that the Department of Human Resources, Labour and Employment advise employers that, in all cases, personal protective equipment (i.e. respirators) is only to be used as a last resort and as an interim solution while engineering controls are implemented. Only certified respirators should be used. In addition, a suitable respiratory protection program must be implemented and the applicable CSA standards followed. Workers will need to be trained in the safe use and maintenance of such equipment.

**Primary Prevention-related Recommendations for Occupational Health and Safety Committees**

Crab processing plants with more than 10 workers are required by the OHS Act to have occupational health and safety committees. According to the Act, such committees "(a) shall seek to identify aspects of the workplace that may be unhealthy or unsafe; (a.1) shall participate in a workplace inspection that an employer is required by the regulations to conduct; (b) may make recommendations to principal contractors, employers, workers, self-employed persons and the assistant deputy minister or an officer for the enforcement of standards to protect the health, safety and welfare of workers at the workplace; (c) shall receive complaints from workers as to their concerns about the health and safety of the workplace and their welfare; (d) shall establish and promote health and safety educational programs for workers; (e) shall maintain records as to the receipt and disposition of complaints received from workers under paragraph; (f) shall co-operate with the assistant deputy minister or an officer who is exercising his or her duties under the Act; and (g) shall perform those other duties and follow those procedures that may be prescribed by the regulations. (OHS 'Act').

Active, effective and well-trained occupational health and safety committees could play a key role in monitoring risks related to occupational asthma to snow crab and in prevention. In the plants visited during this study, occupational health and safety committees appeared to be relatively inactive and members were not always as well trained in issues related to respiratory health as they needed to be. This may well be a problem that exists across the industry. We therefore recommend that

22. occupational health and safety committee members receive training to identify potential hazards in the work place that will affect respiratory health and that they be encouraged to establish a formal process to identify and report issues affecting the respiratory health of workers.



**Shellfish Asthma Working Group Report, May, 2004**  
**Short Version**

We also recommend

23. that committee members receive training to increase their knowledge of signs and symptoms identified with OA or other work-related respiratory problems.

Sulphites used when producing raw crab products and cleaning chemicals used in plants can also threaten the respiratory health of workers. Information we have gathered related to the handling of cleaning chemicals in some plants suggests that more needs to be done to minimize risks from these chemicals. We therefore recommend that

24. the adequacy of WHMIS training in crab processing plants should be evaluated by personnel from the Department of Human Resources, Labour and Employment. .

**Primary Prevention-related Recommendations for WHSCC**

In 1995, the WHSCC introduced an experience rating system for individual employers in which the employer assessment rates are linked to the cost of claims. According to the WHSCC, “[e]xperience rating is designed to improve employer awareness of the importance of safety in the workplace and to achieve equity through the use of rewards and penalties based on the employer’s own accident cost experience compared to the industry’s average cost.” (WHSCC 2002 Classification of Industries and Assessment Rates, p. 2). The experience rating system applies to fish processors. Our study has documented prevalence levels that are not reflected in the history of claims for this problem, a pattern that appears to be related to lack of information/knowledge about eligibility for WHSCC among management, affected workers and health professionals. It also appears to be related to the potential economic impacts of claiming for the worker and perhaps to difficulties obtaining a diagnosis. Experience rating may be adding a third barrier to claims filing among affected workers. Findings from an earlier study (Neis et al. 2001) and in a separate study in process suggest that employers may be discouraging workers from filing claims. At least one employer (not in this study) is reported to have begun paying the medication costs of affected workers in their plant. Workers may also be discouraged from filing claims because of threats of plant closure in a competitive industry with excess capacity and declining quotas. In some cases, plant closures would affect not only their incomes but the incomes of family members.

Given that most claims over the next few years are likely to come from workers who were sensitized prior to this study and prior to the research and knowledge transfer to this province and to employers of research results that could have been used as the basis for designing safer workplaces; given the likely poor relationship that will continue to exist between actual risks of occupational asthma and the number of claims from particular plants thus raising questions about the equity of experience rating; and given the likely possibility that experience rating could contribute to continued under-reporting and related poor information on the extent of the risk to workers from crab asthma,

**Shellfish Asthma Working Group Report, May, 2004**  
**Short Version**

25. we recommend that WHSCC consider not including claims costs in its experience rating for individual crab processing companies for cases of occupational asthma where medical histories indicate symptoms began prior to 2003.

**Primary Prevention-related Recommendations for Further Research**

An objective of this study was to identify production processes and work activities associated with the aerosolization of snow crab allergens and worker exposures to those allergens. A related objective was to identify possible ways to reduce the levels of worker exposure to aerosolized allergens. The project has taken us some way towards understanding the processes, technology designs and ventilation systems associated with higher and lower allergen levels. It has also produced evidence suggesting that enclosure and effective ventilation of steam and allergens produced during cleaning, sawing and probably other manipulations of cooked crab are important. The process used to measure allergen levels has been peer reviewed. However, we recommend that

26. an agency such as National Institute of Occupational Safety and Health (NIOSH) be asked to validate the sampling and analytical methods used in this study. In the interim, a detailed sampling protocol should be developed for use by private consultants who may be engaged to conduct air sampling at a future date.

Since study results to date **suggest but do not confirm** that another way to reduce allergen exposures is by doing the cleaning, sawing and potentially other manipulations of crab (like meat removal) prior to cooking; given that a growing number of processors appear to be switching to raw processing; and, given that this study suggests yields are better with raw processing making it likely this trend will continue, we recommend

27. an experiment be carried out to test the hypothesis that allergen levels associated with processing raw crab are lower than those associated with processing cooked crab. Allergen samples from this experiment will need to be analysed using sera from workers sensitized to raw crab and using sera from workers sensitized to cooked crab.

Our research suggests that some of the respiratory problems we are observing among snow crab processing workers could be linked to endotoxin exposure. Endotoxins are part of the outer membrane of the cell wall of Gram-negative bacteria. They can produce symptoms (e.g. cough, flu like symptoms, fever, chills). Cooking water samples from a laboratory experiment in which forty pounds of crab was cooked revealed the presence of endotoxins. Further endotoxin sampling was carried out during the recent raw versus cooked crab experiment at the Marine Institute. If these latter samples indicate the presence of endotoxins, we recommend that

28. sampling for endotoxins be carried out in selected crab plants during the next processing season.

## Shellfish Asthma Working Group Report, May, 2004 Short Version

We also recommend that

29. a copy of this report be submitted to ASHRAE, ACGIH and NIOSH and comments solicited.
30. steps be taken to develop animal polyclonal antibodies for immunoassay of allergens in the air. This would allow almost unlimited access to reagents for crab allergen air sampling without resorting to sera from sensitized workers.
31. alternative ways to monitor allergen exposures such as through monitoring aerosolized protein levels be explored and results compared with established techniques.
32. research be designed to monitor symptoms in different work environments to improve our understanding of what lower aeroallergen concentrations do for the workplace (i.e. do plants with  $<100 \text{ ng/m}^3$  have better worker health? Can workers who have occupational asthma work without problem in these conditions?)

Given that workers in some plants maintain that respiratory problems tend to be exacerbated during boilover events, we recommend

33. that allergen sampling be conducted during a pre-planned boilover to determine the airborne levels of allergens and other contaminants that may be respiratory tract irritants associated with such events.

### **Secondary Prevention**

Secondary prevention deals with early detection and intervention i.e. early identification of workers with crab asthma and removal from exposure in order to prevent permanent impairment. As we know, one of the risk factors for persistence of asthma once a worker with occupational asthma has been taken off work is the duration of exposure after development of symptoms.

### **Secondary Prevention-related Recommendations for the Workplace Health Safety and Compensation Commission (WHSCC)**

At present, the WHSCC protocol for diagnosing snow crab occupational asthma mainly relies on PFM monitoring to diagnose occupational asthma. The balance of probabilities falls on the worker who receives no support and has to ensure that all the required information is obtained and provided to WHSCC. Our study shows that PFM may not be done adequately because of lack of training and support, as well as for other reasons. More generally, we are concerned that the current requirements of the protocol may be

**Shellfish Asthma Working Group Report, May, 2004**  
**Short Version**

unrealistic, asking too much of workers and of Health and Community Services prior to WHSCC intervention. We therefore recommend that

34. members of the Working Group and Dr. Cartier meet with the WHSCC to review the effectiveness and appropriateness of the snow crab OA diagnostic protocol developed in 2000.

Although positive skin tests to snow crab or positive RAST in a worker suspected of having occupational asthma do not confirm the diagnosis, we recommend

35. consideration be given to changing the protocol so that positive medical history and positive skin test or RAST are considered sufficient to support the diagnosis (the balance of probabilities being on the side of the worker). These workers would then be supported by WHSCC more directly and, if monitoring of PEF (including possibly a period off work), or specific challenges are requested by the WHSCC to confirm the diagnosis, costs associated with these tests would be paid by the WHSCC.

We recommend that

36. the WHSCC recognize that disability associated with occupational asthma involves two components: 1) sensitization to crab which will last for ever and; 2) in some cases, persistent asthma for which disability workers should be reassessed two years after leaving work as is done in Quebec, and
37. the WHSCC include information on the risk of disability and potential eligibility for disability compensation in its communications with industry and workers.

**Secondary Prevention-related Recommendations for the Department of Health and Community Services**

In Newfoundland and Labrador, it is the responsibility of Health and Community Services to diagnose work-related occupational diseases like occupational asthma to snow crab. Once the diagnosis is confirmed, responsibility for compensation, drug reimbursement, etc. falls to the WHSCC. This research suggests that training gaps, turnover in rural and remote health professionals and limited access to appropriate technologies and tests are limiting the capacity of these health professionals to objectively diagnose occupational asthma to snow crab and to effectively manage and treat this occupational health problem. Given the potentially serious health, socio-economic and quality of life impacts of crab asthma, and given that diagnosing crab asthma requires documenting an allergy to snow crab, the presence of asthma and evidence that asthma is worse at work than it is away from work, in order to minimize the risks to workers of misdiagnosis we recommend that:

**Shellfish Asthma Working Group Report, May, 2004**  
**Short Version**

38. physicians working in regions where snow crab processing takes place be trained in issues related to the causes, diagnosis, treatment and compensation of crab asthma;
39. physicians ensure workers are offered the tests needed for an objective diagnosis of crab asthma; and,
40. they review with workers the potential risks and benefits of receiving such a diagnosis, remaining in their jobs, filing a claim with WHSCC, etc.

We also recommend that:

41. health professionals who are working in regions where snow crab processing is taking place receive special training related to occupational asthma to snow crab prior to starting to work in these areas;
42. steps be taken to equip clinics and hospitals with knowledge and technologies necessary to diagnose and treat OA. This includes supplies of peak flow monitors and diary cards that can be loaned to workers.

In addition, we recommend that:

43. safe and standardized (validated in a similar way as done in our study) snow crab extracts (from raw and cooked meat and cooking water) be made available for use in skin tests and RAST tests and that physicians and labs understand the need to use extracts from raw and cooked snow crab (ideally harvested in Newfoundland and Labrador) and know how to procure such extracts.

Peak flow monitoring (PFM) is one tool used to obtain objective measures of lung function that is easily accessible to workers and health care professionals in small communities. However its value is dependent on the knowledge and skills of the professionals who do the training and analyse the results as well as the support they provide to workers. We therefore recommend that

44. health professionals be trained in how to administer and interpret skin tests as well as how to teach peak flow monitoring, to support workers carrying out peak flows, and to interpret the results.

We need to investigate new ways to improve the quality, compliance and reliability of PFM. While more costly, the use of an accurate electronic PFM would decrease errors associated with data entry, reduce the time required to do the PFM at work, could easily be downloaded electronically and analysed with software providing a complete and almost instant report. We recommend

45. Health and Community Services explore the option of lending electronic PFM's to workers required to monitor their breathing.

The WHSCC protocol suggests the use of spirometry (PFT) and PFM but monitoring of methacholine bronchial responsiveness (and in certain cases, specific challenge in the work place) is also in the protocol for cases where the PFM is inconclusive. Because of

**Shellfish Asthma Working Group Report, May, 2004**  
**Short Version**

the cost associated with the methacholine challenge (travel to St. John's or to hospital where it is available, food, accommodations and loss of income, wait lists, etc. we recommend that:

46. PFT and methacholine challenge be made accessible in each health care region. We also recommend accreditation of a pulmonary laboratory to ensure quality and reproducibility of tests across the province thus reducing the number of tests required and improving reliability. Alternatively, WHSCC could consider supporting financially the workers who need to go through this process to confirm or exclude occupational asthma.

**Secondary Prevention-Related Recommendations for the Newfoundland and Labrador Centre for Health Information, Department of Industry, Trade and Rural Development and ACOA**

Under-reporting of crab asthma symptoms to the WHSCC can be expected to continue in the industry for the foreseeable future. This makes it difficult to estimate the scale of the problem and costs to individuals and to the health care system. The Newfoundland and Labrador Centre for Health Information (NLCHI) may be able to indirectly monitor the prevalence and cost of this type of asthma by developing a provincial database on the regional distribution of asthma contrasting regions with crab processing labour forces with those without and examining the age and employment history of asthma sufferers, morbidity and mortality related to asthma, and the health costs associated with asthma treatment and medication. We therefore recommend

47. the NLCHI undertake the development of such a database, link it with WHSCC and other data to help distinguish OA from regular asthma and document, on an ongoing basis, health costs associated with these conditions.

Since development of capacity related to research, prevention, diagnosis and treatment of occupational asthma to snow crab and other shellfish species is a potential source of new and future employment for the province and the Atlantic Canadian region, we also recommend that

48. funding be sought for research on the allergy and occupational asthma risk associated with processing other types of shellfish such as shrimp, sea urchins, surf clams, snow crab and other crab species;
49. Newfoundland and Labrador develop the capacity to manufacture extracts of snow crab and other types of seafood for allergen testing;
50. the capacity to conduct allergen and protein sampling and immunological analyses be transferred to Newfoundland and Labrador

**Shellfish Asthma Working Group Report, May, 2004**  
**Short Version**

**Secondary Prevention-related Recommendations for Further Research**

It is our understanding that very few WHSCC claims for snow crab OA have been completed since a protocol was developed in 2000. In order to better understand the reasons why workers with crab asthma are not completing claims for worker's compensation and to monitor the claims settlement process, we recommend that

51. researchers develop an anonymous mailout survey to be sent to those who have filed claims for compensation for crab asthma asking them to explain the reasons why they decided to file a claim and documenting what has happened since they filed the claim;

and,

52. researchers be given access to anonymized data from the WHSCC's claims database related to shellfish asthma for the past few years and continue to monitor claims and the claims settlement process over the next five years.

RAST is a crude method for documenting sensitization in that you are looking at a large number of allergens. As knowledge develops in the diagnosis and treatment of allergy in general and occupational allergy in particular, we want to improve our methods of diagnosis, treatment and assessment of exposure. This can be done for crab asthma as for other types of occupational asthma. To move towards improved methods we recommend that

53. more sera of sensitized workers be analyzed for reactivity to identify more precisely what they are reacting to. If a protein could be identified to which all sick workers, and only sick workers, react, this might be used as a diagnostic reagent, replacing the raw and cooked crab extracts and cooking water extract currently in use.

**Tertiary Prevention**

Tertiary prevention means minimizing the effects of an established disease such as occupational asthma by administering medications, reducing further exposure, minimizing additional loss of lung function and minimizing the social, economic and quality of life impacts. Our prevalence results suggest that a substantial number of sensitized workers exist in the snow crab processing industry in Newfoundland and Labrador, some of whom are at risk of greater illness if they continue working at their present jobs, but who might also suffer substantial social and economic costs if forced to give up their jobs. Depending on the extent of their sensitization and the speed and success with which primary prevention is able to create jobs with minimal or no allergen exposures in some or all parts of crab plants, it may be possible for some workers to stay at their jobs or to be moved, safely, to new jobs. The safety of such jobs will need to be verified and workers should monitor their symptoms (as well as their spirometry,

**Shellfish Asthma Working Group Report, May, 2004**  
**Short Version**

possibly peak flow at work and methacholine bronchial responsiveness) to ensure that they do not get worse.

**Tertiary Prevention-related Recommendations for the Department of Human Resources, Labour and Employment**

Given employer obligations under the Early and Safe Return to Work program to cooperate in the worker's early and safe return to suitable and available employment with the injury employer, and given the possibility that allergen exposures in some areas will continue to be high enough to trigger symptoms in sensitized workers for the foreseeable future, consideration should be given to the identification of appropriate and safe protective equipment (respirators) and provision of this equipment in conjunction with suitable training for exposed workers.

In relation to personal protective equipment for sensitized workers, we recommend that

54. the Working Group and the Department of Human Resources, Labour and Employment explore with employers of workers who have occupational crab asthma or symptoms suggestive of this disease the option of wearing a respiratory device and appropriate training for the use of such a device if such workers choose to remain working in the crab plant or if an alternative job without exposures is not available.

**Tertiary Prevention-Related Recommendations for the Working Group, Employers and Labour**

At present, the gender division of labour tends to concentrate women in jobs with higher allergen exposures and to limit their ability to move to jobs such as outside work where allergen levels are likely to be lower. We therefore recommend that

55. the Working Group work with the Fish Food and Allied Workers Union and employers to break down the gender division of labour, thereby increasing the employment options of sensitized women workers.

The *Workplace Health and Safety Compensation Act* includes an "Obligation to re-employ" for employers:

89. (7) An employer to whom this section applies shall accommodate the work or the workplace for the worker to the extent that the accommodation does not cause the employer undue hardship.



**Shellfish Asthma Working Group Report, May, 2004**  
**Short Version**

According to the WHSCC's Injured Workers' Handbook,

“All employers are encouraged to accommodate the workplace. However, an employer with a re-employment obligation is required by ‘the Act’ to provide modifications or assistive devices to accommodate the workplace for the worker, unless the employer demonstrates that the resulting expenses will cause undue hardship. The Commission may pay for the modifications and devices that are necessary for the worker to re-enter the labour market in the suitable employment or to return to suitable and available employment with the injury employer.”

56. This suggests that, under normal circumstances, employers or the WHSCC should pay for personal protective devices required by sensitized workers.

**Tertiary Prevention-related Recommendations for Health and Community Services**

In the short term, we recommend that:

57. a health professional (respiratory therapist clinical nurse with special training related to asthma and occupational asthma) be hired with responsibility to travel to crab processing communities to carry out training sessions with health professionals, health and safety committee members and to hold clinics for workers with respiratory problems. This professional could also assist in the development of a process to improve the timeliness of diagnoses.

In the longer term, we recommend

58. an asthma care center be established in each region similar to the one that now exists in Gander to support workers and others with asthma and occupational asthma, as well as health care professionals responsible for diagnosing and treating these health problems. These Centres could facilitate the diagnosis of occupational asthma by helping the worker and health care professionals with the WHSCC protocol, ensuring all tests are completed in a timely manner and test results are provided to the appropriate stakeholders. They could also support communication between workers, various health care organizations and the WHSCC.

Alternatively,

59. the Department of Health and Community Services and the WHSCC establish Worker Health Centres in each region of the province with responsibility for education, training and research related to preventing occupational injuries and disease and for providing diagnostic and other services to workers.

**Shellfish Asthma Working Group Report, May, 2004**  
**Short Version**

A substantial number of current and former crab processing workers in Newfoundland and Labrador are already sensitized to snow crab, many more than those who have filed claims with the WHSCC in the past few years. An appropriate mix of asthma medications can place undue financial strain on sensitized workers leading to the risk of under- or inappropriate medication. These, in turn, can increase the risk of long-term and serious respiratory problems.

We therefore recommend that WHSCC

60. consider paying asthma medication costs for sensitized workers with a diagnosis of occupational asthma.

Unsustainable management of the groundfish and capelin stocks has reduced the employment options within fish processing for workers sensitized to snow crab. Recent quota cuts in some areas suggest these options will be further reduced in the future due to poor management of the crab stocks. These realities, combined with the probable existence of several plants with relatively large numbers of sensitized workers, mean that, even with reduced exposure levels and/or personal protective equipment many workers may not be able to continue processing crab without risking their respiratory health. The number of such workers will substantially exceed the number of alternative jobs available to these workers in many areas.

The situation confronting workers and the crab processing industry is unique and cannot be adequately addressed by normal policies and programs for dealing with individual cases of injury or occupational disease. A more appropriate approach would involve a major, collaborative initiative on the part of federal and provincial departments and agencies and community groups to minimize the risks of occupational asthma and the serious, long term health, quality of life and social and economic impacts of crab asthma for sensitized workers. This initiative must include programs to support transition into early retirement for older workers and, for younger workers, into new types of employment, ideally within the areas where they currently live. Such an initiative could become a model approach for dealing with groups of workers affected by other work-related disabilities who live in remote regions with limited employment alternatives.

We recommend that the Working Group organize

61. a workshop on the crab industry, occupational asthma and its socio-economic impacts bringing together representatives from the federal Departments of Fisheries and Oceans, Health Canada and Human Resource and Development Canada, the provincial Departments of Fisheries and Aquaculture, Health and Community Services, Industry, Trade and Rural Development, as well as the WHSCC, ACOA, the Women and Resource Development Committee and the Newfoundland and Labrador Lung Association, employers and the Fish Food and Allied Workers Union. The purpose of the workshop would be to develop recommendations and identify potential funding sources for the implementation of an early retirement program, counseling and retraining programs, as well as rural economic

**Shellfish Asthma Working Group Report, May, 2004**  
**Short Version**

diversification and job creation projects suitable for sensitized crab processing workers.

We also recommend that

62. funding be sought for a participatory action research project based on a healthy communities model for a community and peer-based counseling, training, health promotion and employment creation project to be piloted in two communities, evaluated for its effectiveness, and used as a basis to monitor the effectiveness of other changes in workplaces, health services and communities implemented in response to this report.

Finally, we recommend

63. an interdisciplinary follow-up study to this one be carried out in 5-10 years time to assess the effects of changes implemented in the wake of this research on prevention, diagnosis, treatment, compensation and socio-economic and quality of life impacts.

And,

64. that the Working Group continue to receive support and funding over the next several years and that it consider broadening its membership to include representation from physicians and from departments and agencies responsible for economic development, job creation and retraining.