Fisheries and Oceans Canada   Pêches et Océans Canada

ST. ANDREWS BIOLOGICAL STATION

Dedicated to Excellence in Aquatic Science since 1908

ENVIRONMENTAL SCIENCE RESEARCH

Understanding the potential environmental effects of a number of industries and activities on the marine environment has been a cornerstone of research at the St. Andrews Biological Station (SABS) for the past half century.

With increasing awareness of the significant environmental changes taking place in today's world, researchers around the globe are examining the interconnectivity of these changes on our aquatic systems. Our research is currently focused on understanding potential environmental effects of climate change, oil and gas production, pesticides, and aquaculture on marine life.

Biological Effects On Marine Life

SABS scientists are developing a multi-disciplinary approach to study the potential effects of climate change on marine life. Research is focused on the response of the American lobster to seawater temperature—a critical factor in its distribution and productivity. Egg production may be affected as the climate changes since reproduction occurs over a narrower range of temperatures than growth or larval development. Current knowledge is sufficient to alert us to the risk, but inadequate to project how great the risk might be. Studies show that time of spawning is controlled by an internal biological clock that is set by day length and temperature. Day length 'tells' the lobster what time of year it is, so the animal 'knows' whether to start the process of preparing to produce eggs. One concern regarding climate change is that favourable temperatures for reproduction may no longer coincide with the day length. If the favourable temperature does not coincide with the brief time of year allotted by the biological clock for spawning, the lobster will not produce eggs.

Salmon aquaculture occurs in the shallow inlets of the Bay of Fundy

Oil dispersant studies in the laboratory

Mussel lines adjacent to a salmon cage site

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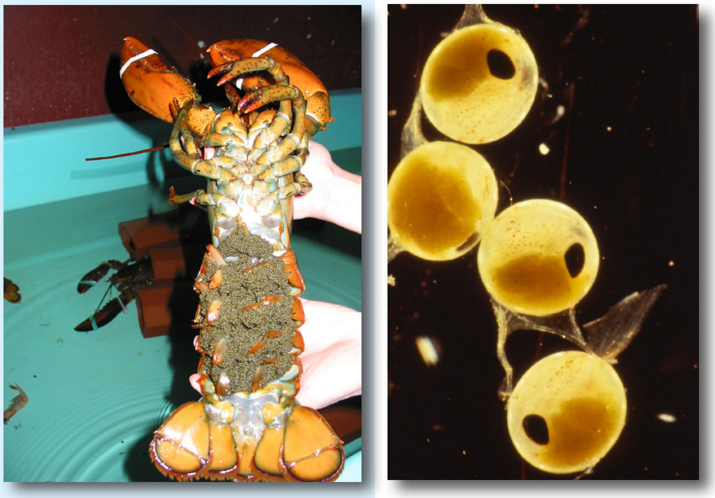
Climate change may also lead to reduced oxygen levels in the marine environment as oxygen is more soluble in cold water. The availability of oxygen is the most important environmental factor required for sustainable Atlantic salmon culture in seawater cages. High-density culture can result in reduced dissolved oxygen in and around cage sites which may worsen if environmental dissolved oxygen is reduced in inshore areas used for farming. Chronic exposure to reduced oxygen can result in metabolic stress, reduction in feed efficiency, and impairment of immune functions of farmed salmon. The ultimate effect on farmed salmon is reduced growth and increased incidence of disease.

A three-year Aquaculture Collaborative Research and Development Program (ACRDP) project will determine how reduced oxygen levels (hypoxia) affect Atlantic salmon growth and immune system function (i.e., performance, disease development, and vaccine efficacy) in the Bay of Fundy. It will also develop a critical oxygen limit as a performance-based standard (PBS) with which to maximize the health and productivity of farmed fish and limit the impact on the immediate environment (i.e. wild fish health, inshore hypoxia). This is the first PBS that will promote monitoring of the welfare of farmed salmon.

Salmon aquaculture takes place in sheltered bays and inlets on both the Atlantic and Pacific coasts of Canada. Small solids and dissolved nutrients released from fish food and from salmon are often considered contaminants. Mussels and kelp grow well in close proximity to salmon aquaculture sites by using these wastes which then provide an extra crop for the farmer. This concept is known as Integrated Multi-Trophic Aquaculture (IMTA). Samples of mussels from IMTA sites are being analysed to determine the condition of these mussels compared to mussels collected away from aquaculture operations. To date, results from this work support the suggestion that mussels grown in an IMTA setting are in as good, or better, condition as those growing in other areas of southern New Brunswick.



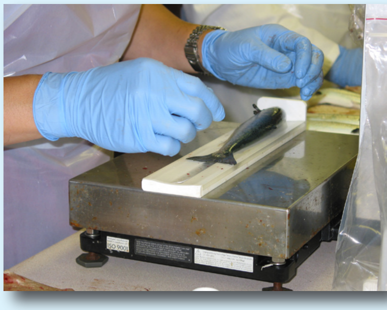
Lobsters extrude eggs in the summer and incubate them under their tail for almost a year. The eggs in this photo have large eyespots and will hatch in a few weeks into a pelagic first stage larvae. Time of hatch can be predicted from the size of the eyespots.

Mussels grown at an ecosystem-based salmon aquaculture farm.

Chemical Effects On Marine Life

Harmful effects (toxicity) of a compound depend not only on its chemical properties but also on the level and length of exposure. Depending on exposure conditions, compounds may kill organisms or impair their ability to maintain a healthy physiological state and change behavioral, physiological, and biochemical processes (sub-lethal responses).

The main goal of this program is to investigate lethal and sub-lethal responses of aquatic organisms after exposure to chemical contaminants. Determining thresholds of effects and comparing those to known environmental concentrations is the basis of all risk assessments. Another goal is to develop a series of diagnostic tests to assess the health of aquatic communities and populations. Identification of conditions for optimum health is critical, for example, in maximizing the growth rate and economic return from cultured fish. The well-being of invertebrate populations is also essential to the good health of the near-shore ecosystem. Current studies focus on the impact of chemical wastes from the offshore oil and gas industry, the effect of chemicals on normal hormonal func-



Measuring effects on Atlantic salmon

tion of the growth and survival of wild juvenile salmon during their seaward migration, the effects of aquaculture therapeutants on non-target species, and the health status of organisms grown in an aquaculture setting.

Decreased growth is a common response in fish exposed to sub-lethal concentrations of chemicals. Our research focuses on biochemical mechanisms involved in the use of the energy derived from food. Atlantic salmon spend their early life in fresh water and then undergo a physiological change that enables them to survive in seawater. This process is called smoltification and is a period in the salmon's life when it is particularly sensitive to changes in its native environment.

Exposure of Atlantic salmon to pesticides and other organic compounds may result in decreased growth and affect smoltification. Studies in our lab have shown that exposure to pesticides commonly used in agricultural practices in the Maritime Provinces and compounds known to be present in effluent from municipal wastewater treatment facilities and industrial operations can result in some reduced growth compared to untreated fish. The concentrations of compounds that the salmon are exposed to in the lab are similar to concentrations of the same compounds in samples collected in the field. The consequences of reduced growth may be failure to survive or thrive at sea. It remains unclear if the growth response observed in Atlantic salmon smolts is specific to the chemical being tested or is a generalized response to stress. Collaborative studies to further investigate this response are ongoing with scientists from universities, the Department of the Environment, Health Canada, and several other DFO research facilities.

Sea lice are ecto-parasites (attach to the surface) of many fish species including Atlantic salmon that can cause problems for penned fish wherever aquaculture is practiced. Therapeutants, including pesticides and drugs, are routinely used to eliminate or control these parasites. Residues of these therapeutants can be released into the surrounding waters, thus raising concerns about potential effects on other organisms living within the area. Consequently, all pesticides and drugs must go through a rigorous review process by Health Canada, the federal department that registers products for aquaculture use before they can be used in the marine environment. In Southwest New Brunswick and in Nova Scotia, the potential effect of these compounds on the American lobster is of particular interest. Research into the effects of sea lice pesticides and drugs on lobster has been carried out at SABS for over 15 years. Research is continuing on the lethal and sub lethal consequences of exposure to various life stages of the American lobster. Data collected during these studies are used for risk assessment and considered by Health Canada in their review process.

Offshore oil and gas production involves the discharge of chemical mixtures directly into the marine environment. These mixtures are referred to collectively as 'production (or produced) water'. Questions have arisen regarding the potential for these compounds to affect fish known to inhabit areas adjacent to production rigs. SABS researchers are working in collaboration with the Centre for Offshore Oil and Gas Environmental Research (COOGER) to investigate short-term (acute) and long-term (chronic) effects of production water on Atlantic cod. Research is focused on determining if short-term or long-term exposures to production water affect survival, reproduction, growth or biochemistry of various life stages of cod.

Chemical dispersants are used to "break up" oil spills in the marine environment. While products used for this purpose are regulated and can only be used in

Studying lobsters exposed to sea lice treatments in a controlled lab experiment. Lobster on left has been exposed.

specific circumstances, there are concerns regarding their potential to affect commercially-important species, particularly in nearshore environments. In association with COOGER, studies have begun to determine the lethal and some sub-lethal effects of exposure on various life stages of cod to dispersants and to dispersant/oil mixtures. Of particular interest is the effect of temperature on the response of cod to dispersants. Research is also underway to investigate other indicators (endpoints) of exposure of fish to chemicals. Specific enzymes found in fish livers are indicative of exposure to oil-type compounds. Laboratory studies are also underway to determine if chemical dispersants or production water can affect enzyme activity in cod.

The ultimate goal of this research is to be able to sample fish and invertebrates from field situations, analyze tissues for the presence and concentration of some of the indicator biochemicals described above and determine whether or not these animals have been exposed to adverse levels of chemicals and/or adverse environmental conditions.

Wave tank at Bedford Institute of Oceanography used for oil dispersant studies.

Published by:
Fisheries and Oceans Canada
Ottawa, Ontario
K1A 0E6
Environmental Science Research at St. Andrews Biological Station
Également disponible en français.

DFO/2010-1699
Cat. No. Fs104-22/2011E-PDF
ISBN 978-1-100-17646-8