ATLANTIC SALMON RESEARCH JOINT VENTURE SCIENCE PLAN 2018-2023

Wild Atlantic salmon (Salmo salar) is a migratory species native across the North Atlantic Ocean from North America to Europe. Natural dangers and human-caused threats which the species encounters in its fresh, estuarine, and marine habitats pose enormous challenges for these fish and to our understanding of why populations continue their decades-long decline. The complexity of the scientific questions over such a large area require the combined capacity of many agencies, and indeed nations, to advance our knowledge and to contribute to solutions. The Atlantic Salmon Research Joint Venture (ASRJV) was established to forge the partnerships and collaboration sufficient to address these urgent and unresolved scientific questions that might otherwise not be undertaken.

This Joint Venture was formed in 2016 with members from agencies and organizations actively engaged in carrying out or supporting research on wild Atlantic salmon. Membership includes: Federal, Provincial and State agencies; Indigenous organizations and governments; non-government organizations; and academia in Canada and the United States. This Atlantic

Salmon Research Joint Venture Science Plan (2018-2023) was developed to articulate priority research themes that if undertaken could resolve some of the complex uncertainties facing wild Atlantic salmon.

STATUS OF ATLANTIC SALMON

Atlantic salmon population abundances have collectively declined in both Europe and North America over the past few decades. Estimated abundances of the North American Atlantic salmon (born in rivers in Canada and United States) in the ocean has declined from just under 2 million fish in the 1970s to less than 1 million fish in this decade, a decline of 45% over that time period. Indeed, in North America particularly in the southern parts of its range, many river stocks are considered to be species at risk of extinction.

WHERE SALMON ARE HAVING DIFFICULTY

Wild Atlantic salmon spend portions of their life-cycle in fresh water and conduct long migrations to and within the ocean. While most direct human-caused stressors are found in the freshwater habitats (spawning and juvenile rearing) this is but one component of their migratory path. Salmon must continue their journey through estuarine and coastal habitats as vulnerable juveniles, grow to mature adults in the open ocean, and return to their natal streams thus facing many pressures in each of these environments. Current science has concluded that changes in the ocean in the past 20 to 30 years, whether the ocean itself or what salmon eat and what eats salmon, are the primary factors causing the decline and limiting the recovery of the populations to previous levels.



Most conservation and management efforts have been focussed on maintaining and improving the freshwater production of juveniles as a way to offset at-sea mortalities.

RESEARCH AND SCIENTIFIC LIMITATIONS TO STUDYING ATLANTIC SALMON

It is recognized that management actions aimed at reversing current trends requires knowledge concerning the locations, times, scale, and causes of salmon mortality throughout their life cycle. Research and studies to understand salmon mortality and decline is challenging for a number of reasons:

- The overall abundance of Atlantic salmon in the North Atlantic Ocean is low;
- Salmon are dispersed over an enormous oceanic area in the North Atlantic basin;
- Given high mortality rates, tracking salmon requires large numbers of individuals to be tagged for sufficient data returns, tags which operate for extended periods are not yet available to study maturing juveniles, and;
- There is a need to follow river-specific populations which individually often have only small numbers of animals.

KNOWLEDGE GAPS

Reviews of factors contributing to the decline of Atlantic salmon in Canada began twenty years ago with a keynote study producing a list of 62 potential factors or mechanisms contributing to the declines in salmon abundance. Ten of the twelve highest-ranked hypothesized factors pointed to the decline of salmon in the marine and estuarine environments. A principal recommendation was to develop a new multidisciplinary research initiative aimed at identifying the cause(s) of the decline in at-sea survival. Likely due to the factors limiting

research in the marine environment, survival studies have largely been concentrated on the freshwater phases of wild Atlantic salmon todate. The estuarine, coastal, and open-ocean environments continue to function as "black boxes" into which salmon juveniles enter and from which some variable percentage return as adults.

The 2015 Minister's Advisory Committee on Atlantic Salmon report suggested that scientific collaboration and information sharing between governments, universities, NGOs and the private sector would be a key element to make advances on the outstanding science questions related to Atlantic salmon. This report called for a scientific research and development network to be formed to work together as one body. The manifestation of this recommendation is the Atlantic Salmon Research Joint Venture.

THE ASRJV SCIENCE PLAN

The objective of the Atlantic Salmon Research Joint Venture Science Plan is to guide the strategic planning and implementation of science initiatives leading to improved understanding of the trends and causes of variation and/or decline in the abundance and distribution of wild anadromous Atlantic salmon.

AREA OF FOCUS 1: PHYSICAL ENVIRONMENT INTERACTIONS

For conservation planning, we require a much better understanding of how salmon respond to the cumulative impacts of changes in the environmental conditions, their limits for adaptation, and the consequences to Atlantic salmon ecology, population trends and survival. Further work is urgently needed on the following research questions.



Environmental temperature

Water temperature affects salmon physiology, behaviour, feeding, growth, disease resistance, ability to cope with stressors (e.g. angling), intra-specific interactions and, ultimately, survival. Temperature may be the single most important physical variable affecting salmon throughout its life cycle, and a thorough and clear understanding of the role of environmental temperature on Atlantic salmon is paramount. Emphasis will be placed on freshwater temperatures and its effect on physiology, metabolism, condition of outmigrating smolts etc. Associated parameters such as low pH, or contaminants such as aluminium and their effects on smolt survival and maturation would also be studied.

Phenological mis-match

The timing of salmon movements has evolved to capitalize on seasonal availability of food or favorable conditions. As such, a decoupling of the coherent timing between the seasonal cycles of salmon and their environment, prey or predators is termed a "phenological mismatch". Anticipated research includes identifying freshwater warming mismatched with estuarine and marine water temperature cycles; delays in smolt migration rates; variations in availability of the riverine and marine prey base associated with changes in hydrology and oceanography.

Dispersal and migration

Physical oceanographic conditions, such as temperature, surface currents, coastal inputs of freshwater, and the abundance or extent of sea ice all likely affect the marine migration of Atlantic salmon. There remains significant uncertainty around the temporal and spatial distribution of salmon at sea and this area of research remains critical for determining the timing, location and causes of marine mortality. Emphasis will be placed on where are salmon at sea in time and space and the location and

timing of marine mortality and linking this with oceanographic phenomena.

AREA OF FOCUS 2: BIOTIC INTERACTIONS

The survival of Atlantic salmon can be affected by biotic interactions occurring in freshwater, estuarine, and marine ecosystems that may be modulated by stressors in these environments.

Prey (quality / quantity / diversity)

Atlantic salmon need to consume high-energy food in order to survive, grow, and eventually reproduce. Changes in prey availability (i.e. abundance and timing) and quality (i.e. energy and lipid contents) have been hypothesized to affect growth and survival of Atlantic salmon and may be affected by climate change. Studies will be conducted to determine the current day quality, quantity and diversity of salmon food prey during all their life cycles.

Predation

Typically more than 90% of Atlantic salmon die at sea, though direct observations of mortality are rare for any salmon populations. In the absence of commercial fishing, predation potentially represents the greatest direct source of mortality for Atlantic salmon in many of their life stages. Research anticipated includes studying the effects of increased abundances of natural predators of salmon.

Competition

Competition for resources with other fish and animals may result in poorer condition smolts and/or fewer smolts as it may affect growth and size-dependent mortality processes such as starvation and predation, constrain access to optimal habitats, or altering foraging behaviour. Such studies will focus on changing river communities and the impact on smolt development and fitness.



AREA OF FOCUS 3: POPULATION-LEVEL EFFECTS

Genetic and physiological characteristics

This Area of Focus considers the rapidly advancing technologies and the recent characterization of the full Atlantic salmon genome which can be used to quantify the molecular/genetic and physiological characteristics of salmon within and across stocks to provide a greater understanding of population level effects. Research avenues would be expected to lead to an improved understanding of the extent to which rapid changes in conditions encountered by Atlantic salmon may have contributed and be contributing to the latitudinal cline in population status and to the capacity of populations to adapt, persist, and recover under changes in the future. The research should contribute to increased understanding on the consequences to adaptation and fitness of induced genetic effects including: the extent to which trends in life history are genetically based, how quickly the induced evolution might occur, and whether such evolution is reversible through direct actions.

"Shaping the future of wild Atlantic salmon science and conservation."

For more information, contact: DFO.ASRJV-PCRSA.MPO@dfo-mpo.gc.ca or visit www.dfo-mpo.gc.ca/science/collaboration/asrjv-eng.html

