New Year’s Message from the President

By Carmel Lowe

As we usher in a new year, it is appropriate to take a few moments to reflect upon the achievements and challenges of the past year—and 2016 brought an abundance of both for NPAFC!

Among the many highlights was progress on the International Year of the Salmon (IYS). A highly successful 2nd scoping meeting was held in Vancouver, Canada, in March and attended by more than 50 participants from industry, academic, not-for-profit, and international organizations interested in the sustainability of these iconic species. The meeting secured broad support for an ambitious multi-year program of activities that aims to improve our understanding of “Salmon and people in a changing world”. Of particular note, the North Atlantic Salmon Conservation Organization (NASCO) agreed to partner with us in the further planning and implementation of this initiative. Since that meeting, IYS has gathered steam over the summer with the establishment of an overall Coordinating Committee as well as North Pacific and North Atlantic Steering committees to ensure effective governance is in-place as planning advances. As I write this letter, logo and other project branding are in development and scientists throughout the salmonsphere have begun brainstorming ideas that will contribute to the program objectives.

Carmel Lowe was born and raised in Ireland. She obtained BSc and MSc degrees in Geoscience from University College Galway and a Ph.D. in Geophysics from Trinity College. In 1988, she moved to Canada for a postdoctoral appointment at Carleton University in Ottawa and subsequently took a position as a Research Scientist with the federal government’s Department of Natural Resources in 1990. Over the following 24 years, she developed extensive experience in the design, development, management, and delivery of scientific research programs that addressed Canada’s priorities related to responsible resource development and public safety in its onshore and offshore territories. Ready for a change, in July 2014 she took an appointment as the Pacific Regional Director of Science at Canada’s Department of Fisheries and Oceans and the Canadian Coast Guard. In this role she manages an approximately 500-strong team of scientific and technical personnel to deliver the scientific knowledge and products required to support effective decision-making with respect to Canada’s aquatic resources and habitats. Carmel is a member of the PICES Governing Council and Chair of the Pacific Salmon Commission’s Committee on Scientific Co-operation. Carmel was appointed NPAFC Representative of Canada in 2015 and was elected NPAFC President in May 2016. She has broad interests in the outdoors and when not working enjoys running, hiking, biking, kayaking, and gardening.
Illegal, unreported, and unregulated (IUU) fishing remains an internationally pervasive and complicated problem. Combating it requires, among other things, improvements in the coverage and effectiveness of existing monitoring, surveillance, and control techniques. In 2016, the Committee on Enforcement made significant advances in this regard by reaching out to the recently established North Pacific Fisheries Commission. Through their engagement, efforts are underway to facilitate the exchange of information regarding each organization’s surveillance plans and sightings of suspicious fishing activities, offering increased deterrence for IUU fishing throughout the North Pacific.

The Committee on Scientific Research and Statistics had a very active year too as evidenced by the many presentations and exchanges at the Annual Meeting showcasing new techniques to improve stock identification, abundance estimates, and forecasting of several salmon species that migrate through the Convention Area as well as new insights into the factors that affect their survival and distribution. Continued new understandings on these topics and other factors that impact North Pacific salmon productivity can be expected as the Committee moves forward with implementation of the new NPAFC 2016–2020 Science Plan.

And speaking of the Annual Meeting, on behalf of the entire NPAFC family I extend a huge thank you to all of our colleagues in Korea for hosting us in the beautiful city of Busan last May. It was an extremely productive meeting that offered us some special insights into the customs and charms of this lovely country, none more so than the visit many of us enjoyed to the Jagalchi Fish Market!

These achievements would not have been possible without the continued dedication and professionalism of the Secretariat under the excellent stewardship of Executive Director Vladimir Radchenko. To all, we are extremely grateful. But I would like to take a moment to especially acknowledge the very fine contributions of Nancy Davis during her two terms as Deputy Director. Nancy’s current term will end soon and she plans to pursue new employment opportunities in her home country, U.S.A. We are very fortunate to welcome long-time NPAFC contributor, Jeongseok Park, as he will take on the role of Deputy Director in early 2017.

It is my special privilege to serve the organization as President in 2017 when we will welcome you all to Victoria, Canada, to celebrate the 25th Anniversary of NPAFC. Until then, I offer my sincerest wishes to you and your loved ones for a happy holiday season and New Year.

See you in Victoria!
Exploring the “Salmosphere”: Challenges and Opportunities in Managing Salmon in the North Atlantic

By Peter Hutchinson and Daniel Morris
North Atlantic Salmon Conservation Organization (NASCO)

Salmon are an important biological and economic resource throughout their range, including the North Pacific and North Atlantic Oceans and the Baltic Sea (collectively referred to as the “salmosphere”). They face many challenges and uncertainties not least those associated with climate change. The North Pacific Anadromous Fish Commission and the North Atlantic Salmon Conservation Organization (NASCO) have agreed to lead a major new initiative throughout the salmosphere, the International Year of the Salmon (IYS), to raise awareness of what can be done to ensure salmon and their varied habitats are conserved and restored, and to stimulate investment in research to support management. In this article, Peter Hutchinson, Secretary of NASCO, and Dan Morris, Head of the US Delegation to NASCO, describe the objectives and work of NASCO, the status of Atlantic salmon stocks and the challenges they face, and the many measures being taken to conserve them through NASCO and the international research priorities agreed by NASCO’s International Atlantic Salmon Research Board (IASRB).

While Atlantic salmon also occur within the Baltic Sea, they are managed under a separate regime (initially through the International Baltic Sea Fishery Commission (IBSFC), which ceased to exist on 1 January 2007, and subsequently through a bilateral arrangement between the European Union and the Russian Federation) and are not covered in this article.

Background

The Atlantic salmon, *Salmo salar* L., is highly prized as a food and recreational fishing resource. It has special value to local culture, and the general public is willing to pay to conserve the species, even people with no desire to exploit it. While there are more than 2,500 salmon-producing rivers in the North Atlantic area, the peak total reported nominal catch for this area was only 12,500 tonnes (in the mid-1970s) and in 2015 this catch was only approximately 1,300 tonnes.

Prior to the 1960s, exploitation of salmon in the North Atlantic was largely by States of origin and management was at a national level. With the development of distant-water fisheries at West Greenland, and later in the northern Norwegian Sea and around the Faroe Islands, rational management required an international forum. The Convention for the Conservation of Salmon in the North Atlantic Ocean entered into force in October 1983 and created a new regional fisheries management organization, the North Atlantic Salmon Conservation Organization (NASCO).
Structure and Functions of NASCO

NASCO’s objective is to contribute, through consultation and co-operation, to the conservation, restoration, enhancement, and rational management of salmon stocks in the North Atlantic Ocean, taking into account the best scientific evidence available to it. The Convention prohibits fishing for salmon beyond areas of fisheries jurisdiction of coastal States and in most areas beyond 12 nautical miles from the baselines. The exceptions are in the West Greenland Commission area, where fishing is permitted up to 40 nautical miles from the baselines, and at the Faroe Islands, where fishing is permitted throughout the area of fisheries jurisdiction. This prohibition has created an enormous protected zone or “sanctuary” free of salmon fisheries. In the late 1980s, NASCO became aware of the activities of a small number of vessels, previously involved in the northern Norwegian Sea salmon fishery but registered to non-NASCO Parties, that were fishing for salmon in international waters. NASCO was able to respond quickly through diplomatic action and there have been no sightings of these activities since 1993. Measures were also taken to improve the exchange of information on any illegal, unreported, and unregulated (IUU) fishing activity by non-NASCO Parties which was derived mainly from airborne surveillance activities.

NASCO currently has six Parties: Canada, Denmark (in respect of the Faroe Islands and Greenland), the European Union, Norway, the Russian Federation, and the USA. Any other State that exercises fisheries jurisdiction in the North Atlantic or that is a State of origin for salmon stocks subject to the Convention may accede to the Convention, subject to the approval of the Council. With the exception of Iceland (which withdrew from NASCO at the end of 2009 for financial reasons but has indicated its intention to re-join when the situation improves), only France (in respect of St Pierre and Miquelon) could currently accede to the Convention. St Pierre and Miquelon are islands to the south of Newfoundland, Canada, that are a self-governing territorial overseas collectivity of France. For the time being, St Pierre and Miquelon participates as an observer and reports on its internal-use fishery (~3 tonnes) and sampling programme. NASCO also welcomes participation in its work from inter-governmental organisations, including NPAFC, and also from its 37 accredited non-government organisations (NGOs) whose input to NASCO is coordinated through two co-chairpersons.

NASCO consists of a Council, three regional Commissions (North American, North-East Atlantic and West Greenland Commissions) and a Secretariat. In 2001, the Council established the International Atlantic Salmon Research Board (IASRB), supported by a Scientific Advisory
Group, to promote collaboration and cooperation on research into the causes of marine mortality of salmon and the opportunities to counteract this mortality.

The Council of NASCO provides a forum for consultation and co-operation and for the study, analysis, and exchange of scientific information. It facilitates co-ordination of the activities of the Organisation’s three regional Commissions; makes recommendations concerning the undertaking of scientific research; supervises and co-ordinates the administrative, financial and other internal affairs of the Organization; and co-ordinates the external relations of the Organization. The Council has agreed to a range of agreements, resolutions, and guidelines relating to the management of salmon fisheries; habitat protection and restoration; and aquaculture, introductions and transfers; and transgenics.

The Commissions provide fora for consultation and co-operation, propose regulatory measures for fisheries that harvest salmon originating in the rivers of other Parties, and make recommendations on the undertaking of scientific research.

**Scientific Advice**

NASCO has gone to great efforts to ensure it obtains the best available scientific advice to inform its work and that this advice is independent and free from political influence. Annually a request for advice is made to the International Council for the Exploration of the Sea (ICES). When there has been a need to bring together new knowledge on specific issues, international symposia and workshops have been convened to focus on both scientific and management issues, e.g., in relation to salmon aquaculture and mortality of salmon at sea.

In addition to the core advice which includes provision of information on stock status and catch options or alternative management advice with an assessment of risks relative to the management objective, ICES has also been requested to advise on other issues. In recent years, these have included advice on the impacts of salmon farming, the bycatch of salmon in pelagic fisheries, the diet of salmon during their marine phase, and successes and failures of restoration and rehabilitation programmes (see www.nasco.int/scientificadvice.html). Since 2005, ICES has been requested to provide multi-annual catch options for all three Commissions and this advice has formed the basis for multi-annual regulatory measures/decisions.

Information provided by ICES indicates that the total abundance of salmon at sea prior to any fisheries (PFA) has declined from approximately 7 million fish in the early 1980s to approximately 3 million fish today (Figures 1 and 2). The decline is particularly marked for multi-sea-winter salmon from southern river stocks. The decline in the abundance of spawners has been less marked than the decline in the abundance of salmon from the North American stock complex (Source: ICES 2016).
cline in PFA, but considering status only at the stock complex level can mask trends in abundance. Many individual river stocks are below their conservation limits (Figure 3) and some are critically endangered. A major factor in this decline in abundance has been increased mortality at sea with a marked decline in return rates of adults since the early 1980s. This decline in abundance has necessitated major sacrifices in harvests all around the North Atlantic.

Management of Salmon Fisheries

NASCO’s goal is to promote the diversity and abundance of salmon stocks and maintain all stocks above their conservation limits. Since NASCO’s establishment, the catch in distant-water salmon fisheries in the North Atlantic has fallen markedly as a consequence of regulatory measures/decisions adopted by NASCO (see www.nasco.int/fisheries.html). The Northern Norwegian Sea fishery, which at its peak harvested around 1,000 tonnes, was immediately ended when the Convention entered into force. The distant-water fisheries at Greenland and the Faroe Islands have been subject to regulatory measures/decisions agreed by NASCO in most years since 1984. These measures have resulted in major reductions in harvests to the extent that an internal-consumption only fishery has been conducted at Greenland since 1998 and there has been no fishery at the Faroe Islands since the mid-1990s (catches peaked in this fishery at approximately 1,000 tonnes in the early 1980s; Figure 4).

The salmon fishery at West Greenland exploits salmon that would have been destined to return as multi-sea-winter fish from both the Southern European and North American stock complexes. In recent years, there has been an increasing proportion of North American-origin salmon in the fishery, including salmon from southern areas which are classified as endangered or at risk. In 2015, as part of a new multi-annual regulatory measure, Greenland unilaterally committed to limit the total annual catch for all components of its fishery to no more than 45 tonnes annually in 2015, 2016, and 2017, with any overharvest in a given year resulting in an equal reduction in the catch limit in the following year. Greenland also committed to improve the monitoring, management control, and surveillance of its salmon fishery with the objective of achieving full catch

Figure 3. Attainment of conservation limits for individual rivers on the east coast of North America (Source: ICES 2016).
accountability. The monitoring and control of the fisheries conducted by the other members of the West Greenland Commission (i.e., Canada, the European Union, and the United States) will be assessed in 2017. This is consistent with the NASCO Convention which requires that measures taken by States of origin are taken into account in setting regulatory measures. This “back pressure” has resulted in major reductions in fishing effort and an increasing use of catch and release fishing all around the North Atlantic (more than 195,000 salmon were reported to have been caught and released in 2015).

NASCO guidelines recommend that fishing on stocks that are below their conservation limit should not be permitted but if this occurs, because of overriding socio-economic factors, fishing should be limited to a level that will still permit stock recovery within a stated timeframe. ICES advises that mixed-stock fisheries, which predominantly operate in coastal waters, present particular threats to stock status. Two-thirds of the total North Atlantic catch of salmon is now taken in fresh water; the proportion of the catch taken in coastal waters having declined markedly over the last five years. Nonetheless, challenges remain because ICES had advised that in 2015 33% of the catch in the North-East Atlantic and 9% of the catch in North America were taken in coastal waters.

**Habitat Protection and Restoration**

Much salmon habitat was lost as a consequence of the Industrial Revolution and this must have been a major contributory factor to the decline in wild salmon stocks. Causes include physical, chemical, and biological factors, such as hydro-electric dams, gravel abstraction, canali-

sation, water abstraction, and pollution. However, with the decline of heavy industry and improvement through restoration initiatives, there have been significant gains in recent years but challenges undoubtedly remain. The goal for NASCO is to maintain and, where possible, increase the current productive capacity of Atlantic salmon habitat.

Under a NASCO Plan of Action relating to habitat protection and restoration, each jurisdiction is required to develop a comprehensive plan to protect and restore habitat and to establish inventories of salmon habitat (see www.nasco.int/habitat.html). A major advance has been the establishment by NASCO of a database of salmon rivers, publicly available through an interactive website (see www.nasco.int/rivers_cm.html), which is currently being revised to ensure that the stock categories used better reflect risks to the stocks.

**Aquaculture, Introductions and Transfers, and Transgenics**

When NASCO was established, production of farmed salmon in the North Atlantic was around 25,000 tonnes. By 2015, this production had increased to more than 1.6 million tonnes which represents about 1,200 times the harvest of wild salmon. NASCO’s goal is to minimise the possible adverse impacts of aquaculture, introductions and transfers, and transgenics on the wild stocks of Atlantic salmon (see www.nasco.int/aquaculture.html). While progress has been made in both understanding impacts on the wild stocks and the measures used to minimise these effects, challenges remain particularly with regard to impacts from sea lice and escaped farmed salmon. The development of resistance in sea lice to therapeutants and the recent finding that a large...
number of Norwegian wild salmon populations exhibit widespread introgression of farmed salmon genomes are a concern and challenge both for the industry and those charged with conserving the wild salmon.

Guidance on Best Management Practices, developed jointly with the International Salmon Farmers Association, establishes the following international goals:

- 100% of farms to have effective sea lice management such that there is no increase in sea lice loads or lice-induced mortality of wild salmonids attributable to the farms; and
- 100% of farmed fish to be retained in all production facilities.

NASCO has also agreed on guidelines for stocking Atlantic salmon, introductions and transfers, and transgenic salmon (see www.nasco.int/pdf/agreements/williamsburg.pdf); for activities concerning the parasite Gyrodactylus salaris (see www.nasco.int/gyrodactylus.html); and for stock rebuilding programmes (see www.nasco.int/stock.html).

Commitment to NASCO Agreements

Following a performance review of the challenges NASCO faces in the management and conservation of wild Atlantic salmon and ways in which these challenges may be met, each Party/jurisdiction has developed Implementation Plans detailing the measures to be taken over five-year periods (2007–2012 and 2013–2018) in order to improve commitment to NASCO's agreements. These plans, and the annual progress reports on them, are subject to critical evaluation by a Review Group comprising representatives of the Parties and NASCO's accredited NGOs (see www.nasco.int/implementation_plans.html). Furthermore, since 2014, NASCO has held Theme-based Special Sessions (mini symposia with invited speakers and presentations by Parties and NGOs) on topics related to NASCO agreements to allow for a detailed exchange of information and identification of best practice. These sessions have been very informative and well received and allow input from all delegates. The reports are available at www.nasco.int/reports_other.html.

Research Priorities

Through NASCO’s IASRB a major, innovative programme of co-operative research on salmon at sea, the SALSEA Programme, was developed and the first phase (2006 - 2011), which focused on improving understanding of the distribution and migration of salmon at sea, was implemented through a public/private partnership. Surveys were conducted in both the eastern and western North Atlantic and there was enhanced sampling of the fishery at West Greenland. These results were co-ordinated with other research efforts and included review of scientific literature and analyses of samples from earlier studies using newly available analytical techniques (see www.nasco.int/sas/salsea.htm).

The first phase of the SALSEA Programme delivered improved understanding of the distribution and migration of salmon at sea and new insights into the marine ecology of salmon, including feeding and growth, competition, and predation. New tools with the potential to support management have been developed, such as migration models providing estimates of migration routes under different oceanographic conditions and supporting decision-making, e.g., in relation to the siting of marine development projects. Improved understanding of the distribution and migration of post-smolt salmon at sea, obtained from both marine surveys and modelling studies, should also assist in refining estimates of salmon by-catch in pelagic fisheries targeting species such as mackerel. New genetic baselines have been established and these are being used to support management (see www.nasco.int/sas/salmonsummit.htm).

Given that marine mortality is currently high and that management options in the ocean are limited, the goal is to maximise the number of healthy wild salmon that go to sea by focusing actions on factors in fresh, estuarine, and coastal waters. In that regard, the IASRB has identified partitioning marine mortality of salmon as its current research priority and now seeks to implement an international telemetry programme, SALSEA-Track. This programme aims to identify the migration routes of emigrating post-smolts, quantify the mortality occurring at different points along the migration route and how it varies from year to year, and identify the factors causing the mortality, e.g., predation, aquaculture, or renewable energy installations (see www.nasco.int/sas/pdf/archive/other_reports/SALSEA_TrackBrochure.pdf).

Smolts leaving rivers draining into the Gulf of St Lawrence, Canada, have been tracked through the Strait of Belle Isle, and smolts entering the Gulf of Maine, USA, have been tracked as far north as Newfoundland. There are plans to extend this capability into the Labrador Sea. In the North-East Atlantic, most acoustic tagging of salmon have been conducted in estuaries and fjords but there are also ambitious plans to extend this tracking capability seaward. SALSEA-Track will require international collaboration and partnerships among scientists and industry in seeking answers to key questions relating to the conservation and management of Atlantic salmon. It will involve collaboration with researchers and organisations working on a variety of other marine species that utilise the North Atlantic Ocean.

The International Year of the Salmon (IYS)

These are challenging times for the Atlantic salmon. The IYS is a very good opportunity to raise awareness of the factors driving salmon abundance, of the environmen-
tal and anthropogenic challenges they face, and of the measures being taken to address these. Such activities should also be supportive of new research in the North Atlantic and hopefully allow the SALSEA-Track Programme to be implemented. The focal year, in 2019, will allow for concerted and coordinated outreach initiatives, public engagement efforts, and education activities. A recent initiative in the United States called "Species in the Spotlight: Survive to Thrive" (see www.nmfs.noaa.gov/stories/2015/05/05_14_15species_in_the_spotlight.html) has successfully raised the profile of the species involved, including the Atlantic salmon and it is anticipated that the IYS will do the same around the salmosphere. NASCO looks forward to cooperating with NPAFC and core partners in the Atlantic and Baltic in ensuring the success of this important international endeavour. It is an excellent opportunity to rally public and political support for the iconic salmon species that NASCO and NPAFC were established to conserve.

Reference

Bald eagle. Photo credit: Tourism Victoria.
Northeast Pacific Resident Orca Population Recovery: Is the Key Tied to Restoring Chinook Salmon Abundance?

By Madeline Young
2016 NPAFC Intern

Well-informed management of endangered or threatened predator and prey populations often requires a thorough understanding of predator diets (Ford et al. 2016). This is becoming ever more apparent with an endangered population of killer whales (Orcinus orca) in the eastern North Pacific that appears to feed almost exclusively on Chinook salmon—one of the least abundant species of Pacific salmon—during the summer months.

Orcas have a global distribution and they function as a keystone species in marine ecosystems, meaning they have a disproportionately large effect on these ecosystems relative to their abundance. Globally, orcas are considered a single species with a diverse diet; however, numerous distinct populations exist that appear to specialize on specific prey (Riesch et al. 2012), which may make them particularly vulnerable to reductions in the availability of their preferred food source (e.g., Ford and Ellis 2006). It is believed that these prey specializations are learned behaviours transmitted across generations through social interaction—commonly referred to as orca cultures (Ford et al. 1998; Riesch et al. 2012).

Several distinct orca populations are known to exist in sympatry, with the most well-studied being two iconic “ecotypes” found in the coastal waters of British Columbia and Washington State, traditionally referred to as “transients” (or Bigg’s killer whales) and “residents”. These two ecotypes differ genetically, acoustically, and culturally as well as specializing on completely different prey types (DFO 2016). The diet of transient orcas consists entirely of marine mammals, with the most common prey including seals, sea lions, and porpoises. Resident orcas, on the other hand, are exclusively fish-eating cetaceans that have been found to specialize in consuming Pacific salmon.

The resident ecotype consists of two distinct populations—northern and southern residents. Although there is considerable overlap between their distributions, they are not known to interact (Figure 1). Resident orcas have a complex matrilineal society consisting of strong family units called matrilines that are composed of an older female and all of her offspring. One or more matrilines that travel together are referred to as a pod and a group of pods that share common ancestry are referred to as clans.

The northern resident orca population is composed of three clans (A, G, and R clans) with the total population numbering upwards of 220 whales (CWR 2017). They are most commonly seen in waters from central Vancouver Island to Dixon Entrance off the north coast
of Haida Gwaii, although there are reported sightings from coastal waters off the central Washington coast to Southeast Alaska (DFO 2011). Critical habitat for this population during the summer and fall has been identified as Johnstone Strait and southeastern portions of Queen Charlotte Strait (Figure 2), with little known about their distribution in the winter and spring. The northern residents are currently listed as threatened under the Canadian Species at Risk Act (SARA).

The southern resident orca population consists of one clan (J clan) composed of three pods (J, K, and L pods). During the summer and fall, they are most commonly reported in the exceedingly industrialized and high-traffic coastal waters of the Salish Sea. Critical habitat in the summer months includes transboundary waters of southern British Columbia and Washington State, including Haro Strait, Boundary Pass, the eastern portion of the Juan de Fuca Strait, and southern portions of the Strait of Georgia, as well as Puget Sound (Figure 3). Like the northern residents, there is a significant lack of information on the distribution of southern residents during the winter and spring; some are known to remain in the same general area year-round, while others appear to expand their range over much greater distances and have been reported from coastal waters of central California to Haida Gwaii (DFO 2011).

Southern resident orcas have been listed as endangered in Canada under the SARA since 2003 and in the United States under the Endangered Species Act (ESA) since 2005. Historically, the southern resident population is thought to have numbered upwards of 140 whales (NMFS 2014). During a live-capture fishery for aquaria from 1967–1973, however, the population was severely depleted, and in 1974 consisted of just 71 individuals (Ford et al. 2000; NMFS 2014). Since this time, the southern residents have not experienced any consistent population growth (Figure 4; DFO 2011; NMFS 2014) and as of December 31, 2016, the population was estimated to number 78 whales (CWR 2017). Small population sizes, low reproductive rates, and a variety of anthropogenic factors, such as reduced prey availability, acoustic and physical disturbance, and environmental contamination, are all issues that may act to prevent the recovery of both northern and southern resident populations (NMFS 2008; DFO 2011).

A series of studies on the nature and extent of diet specialization in resident orcas in British Columbia and Washington State began in the 1970s (Ford et al. 1998). Analysis of surface prey remains showed significant support for a dietary preference of Pacific salmon, specifically Chinook salmon, in both northern and southern orca populations during the summer (Ford et al. 1998; Ford and Ellis 2006). Selective foraging for Chinook salmon despite a higher abundance of other Pacific salmon species available during certain times was observed—a possible explanation for which being the large size and high fat content of Chinook compared to other species, as well as its year-round presence in coastal waters (Ford et al. 1998; Ford and Ellis 2006). Chinook salmon abundance levels were also shown to be negatively correlated with resident orca mortality rates and positively correlated with calving rates, although to a slightly weaker degree (Ford and Ellis 2006). In addition to Chinook, Ford and Ellis (2006) found that chum salmon was also consumed in significant amounts from September–October by both resident populations.

More recent studies by Hanson et al. (2010) and Ford et al. (2016) have focused solely on the endangered southern resident population and have provided further support for a dietary preference of Pacific salmon, particularly Chinook salmon.
for Chinook salmon being their prey of choice during the summer months. Using genetic analysis of orca feces, Ford et al. (2016) found Chinook to make up 79.5% of samples collected from May–August, followed by coho salmon at 15%. Hanson et al. (2010) obtained similar results, and in both studies, a shift towards coho in the late summer was also observed, coinciding with run timing of coho salmon around the San Juan Islands. This may be an indication that coho salmon is more significant to the diet of southern residents than previously thought (Ford et al. 2016). Interestingly, a distinct fish-eating population of orcas in Prince William Sound, Alaska, has been found to feed primarily on coho salmon (Saulitis et al. 2000), indicating some similarities in diet between the two distinct populations (Ford et al. 2016). It is clear, however, that southern residents are not consuming other Pacific salmon species in proportion to their availability (Ford et al. 2016). To exemplify this, “during the peak of their run, sockeye salmon are often greater than 10-fold more abundant than Chinook salmon, but Chinook salmon were estimated to contribute > 70% of the whales’ diet, even during the peak of sockeye runs” (Ford et al. 2016 p. 10). Additionally, there are large returns of pink salmon to the Fraser River in odd years, and pink salmon were almost entirely absent from the samples collected (Ford et al. 2016).

Genetic stock identification of prey consumed by resident orca populations has revealed that in general, residents consume Chinook salmon originating from a variety of spawning locations (DFO 2010; Hanson et al. 2010). However, a vast majority of Chinook salmon consumed during summer appears to originate from the Fraser River.

![Critical habitat for northern resident orcas as designated by the Canadian Species at Risk Act (SARA). Figure source: DFO 2011.](image)

Figure 2

![Critical habitat for southern resident orcas as designated by the Canadian Species at Risk Act (SARA) and the US Endangered Species Act (ESA). Figure source: DFO 2011.](image)

Figure 3
from the Upper Fraser, Middle Fraser, South Thompson River, and Lower Fraser stocks. In comparison, only 6–15% appeared to originate from the Puget Sound area rivers. Considering northern residents, 64% of Chinook salmon consumed in whale critical habitat was found to originate from the Fraser River system (DFO 2010). Information of this nature is critical, as many Chinook salmon populations in the Pacific Northwest are considered at risk themselves, with several Fraser summer stocks of medium to high conservation concern, and the Puget Sound Chinook salmon listed as threatened under the ESA (PSC 2008, as cited in Hanson et al. 2010; NMFS 2016b).

Although the Fraser River system is likely the most important source of Chinook salmon for resident orcas during the summer, other smaller stocks are expected to be important during other times of year and in different geographical locations (DFO 2010). For example, preliminary investigations by the National Marine Fisheries Service (NMFS) and collaborating scientists suggest that the winter diet of southern resident orcas consists largely of Chinook salmon consumed from a wider variety of spawning locations, including but not limited to Chinook originating from the Columbia and Snake River systems, of which several salmon stocks are listed as threatened and endangered under the ESA (NMFS 2014, 2016a, 2016b). The proportion of Chinook salmon consumed from these river systems compared to other major river systems on the West Coast, such as the Fraser, Klamath, and Sacramento, is the focus of ongoing research (NMFS 2016a).

The consumption of Pacific salmon by resident orcas is not only of concern to whale recovery efforts, but also to salmon biologists and managers interested in the contribution of orca predation to the natural mortality of salmon. It has been estimated that Chinook salmon consumption by both northern and southern resident orca populations exceeds 1,000,000 fish annually, which “is roughly equivalent to the total combined commercial and recreational harvest of Chinook salmon in marine waters between Southeast Alaska and Oregon in recent years” (DFO 2010 p. 5). As this source of salmon natural mortality is so high, it requires that orca consumption be considered in the allocation of West Coast salmon fisheries (The Canadian Press 2016). It is also known that resident orcas tend to select larger Chinook salmon, specifically 4-to 5-year-olds, weighing 8–13 kg, although Chinook of all age classes are consumed (Ford et al 2006; DFO 2010). Due to the interconnected nature of both predator and prey populations, a multispecies approach is an essential step towards effective management of both salmon stocks and orca recovery efforts.

Due to the listing of the southern resident orca population as endangered in the US and Canada, NMFS and Fisheries and Oceans Canada (DFO) have adopted recovery strategies for southern resident orcas, with the Canadian strategy also covering the threatened northern resident population (NMFS 2008; DFO 2011). Anthropogenic threats to resident orcas listed in the recovery strategies include quality and availability of prey, acoustic and physical disturbance, and environmental contamination. Due to

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**Figure 4.** Southern resident orca population trend. Figure source: NMFS 2014.
significant knowledge gaps, however, the relative importance of each threat is not discussed in either recovery strategy (NMFS and DFO 2011). Despite these knowledge gaps, some management activities have been undertaken since the adoption of these recovery strategies to protect and recover the southern resident population. In the US, for example, the ESA requires that all federal actions must be reviewed to ensure that they do not directly impact the southern resident orcas or their prey. To exemplify this, it is known that southern resident orcas consume Columbia River and Sacramento River salmon; therefore, the whales have been included in the assessment of the Federal Columbia River Power System as well as state and federal water projects in California that affect multiple salmon stocks listed under the ESA.

An independent science panel was also jointly appointed by NMFS and DFO in 2011 to assist in reviewing the best available scientific information on the effect of salmon fisheries on southern resident orcas (Hilborn et al. 2012). The science panel met during three workshops from 2011–2012 and determined that reducing Chinook salmon harvest would not necessarily lead to an equivalent increase in prey available to the southern resident population and thus may not have a positive effect on their rates of population increase (Hilborn et al. 2012). It was concluded that, although elimination of ocean Chinook salmon fisheries along with the management of freshwater fisheries for maximum recruitment would result in a long-term increase in Chinook salmon abundance, the short term benefits to the whales would be minimal. Ocean Chinook salmon harvest rates are already very low (around 20%), limiting “the opportunity for reductions in Chinook salmon harvesting to increase the abundance of Chinook salmon” (Hilborn et al. 2012 p. ix). Additionally, forgone ocean Chinook salmon harvest would not necessarily consist of salmon originating from stocks that are important to the southern resident orcas, and would also consist of a mixture of mature and immature fish. As resident orcas are known to selectively forage for larger, more mature Chinook salmon, the immature salmon escaping an ocean fishery may die of another cause before being targeted for consumption by resident orcas. Another confounding factor is that other predators feed on the same Chinook salmon stocks as the southern resident orcas, including the northern resident orca population, harbour seals, and sea lions, further reducing any increase in prey availability to orcas gained from reductions in ocean catch of Chinook salmon. The panel also determined that other cyclic changes in oceanic conditions would likely have a greater impact on prey availability than impacts of fishing (Hilborn et al. 2012).

With respect to management activities being undertaken in Canada, an action plan for implementing the
A recovery strategy for northern and southern resident orcas has recently been proposed by DFO, outlining measures that need to be taken to address threats to the resident populations and monitor their recovery (DFO 2016). A total of 94 measures were listed addressing the main anthropogenic threats to orcas discussed in the recovery strategy, as well as measures to protect critical habitat. With respect to prey availability, investigation of strategic fishery closures and protected areas were listed as potential ways to reduce prey competition between humans and orcas and protect important foraging locations. Continued implementation and support of the wild salmon policy and recovery plans, and protection of freshwater habitat of important salmon stocks were also addressed, as well as continued research into year-round distribution and diet of resident orca populations.

Some criticisms of this action plan have been put forward, including that it focuses too heavily on continued research. Although this is important, some believe that specific actions need to be taken as soon as possible to promote population recovery (Nixon and Venton 2016). Another criticism of the proposed action plan is that it combines recovery requirements for the northern and southern resident populations (Nixon and Venton 2016; Tarantino 2016). It has been stressed that there is a heightened urgency to protect and stimulate the recovery of the endangered population of southern residents as they face a larger number of threats compared to the northern population. The southern residents have a much smaller population size, have experienced multiple periods of decline, and exhibit a current meager steady growth rate of 1.1% per year (Ford et al. 2011, as cited in Tarantino 2016). The critical habitat of the southern resident orcas is also located in a highly urban and industrialized area that is intersected by a major shipping route. Marine traffic and underwater noise—which affect the whales’ ability to feed—will only continue to increase in critical habitat due to continued development of ports in southwest British Columbia. A recent example is approval for expanding Kinder Morgan’s Trans Mountain Pipeline to move 890,000 barrels of diluted bitumen and crude oil from Alberta’s tar sands every day to a marine terminal with increased capacity in Burnaby. This expansion alone will bring tanker traffic in the area from five to 34 tankers per month and greatly increase the risk of an oil spill in southern resident orca critical habitat (Tarantino 2016; Tasker 2016).

Impatient for action to protect and promote recovery of the iconic southern resident orca population, a group of anglers from British Columbia have taken it upon themselves to feed the endangered population—with hatchery fish (Puri and Corday 2016). This unique plan, recently approved by DFO, has been met with criticism. Members of the Vancouver Island Anglers Coalition plan to buy and raise Chinook salmon at a hatchery in Port Alberni, which will tag the fish before releasing them into the Sooke River near Victoria. The first batch of 200,000 salmon will be released in May 2017. Opponents of the plan warn against possible negative impacts of hatchery fish on
wild populations and state that restoration of important Chinook salmon stocks in the Fraser River is what is really needed to promote the recovery of the southern resident orca population. It is expected that 2–4% of the released fish will return as adults (Kirby 2016), but there is also no guarantee that the returning fish will be consumed by the southern residents as many other species are known to prey on Chinook salmon.

What would a continued decline in Chinook salmon abundance in the Northeast Pacific mean for resident orca populations? Would they be able to adapt? These questions were asked of Michael Ford, orca and salmon researcher and Director of the Conservation Biology Program at the Northwest Fisheries Science Center, Seattle. The issue of prey abundance and resident orca population growth is a complex issue (mike.ford@noaa.gov, pers. comm.). “Considering the endangered southern residents and their supply of Chinook salmon in the Salish Sea, the population is already at risk of extinction so any decreases in their preferred food source would likely exacerbate that risk”, said Ford.

“That being said, the southern resident population is also known to range well beyond the Salish Sea and prey on numerous salmon stocks along the coast from California to British Columbia. Additionally, trends in Chinook salmon stock abundance have not been uniform along the coast, with some showing an increase in abundance, while others have shown a decrease”.

Interestingly, Ford states that there is already some evidence to suggest that the distribution of southern resident orcas has shown some response to these changes in Chinook salmon abundance. Moreover, although there is strong evidence for a reliance on Chinook salmon by the southern residents during the summer, they have been shown to switch to more abundant coho and chum salmon in the late summer and fall (Hilborn et al. 2012; M. Ford, pers. comm.). It is therefore understood that the southern residents have some flexibility in their diet, but, according to Ford, “we don’t really know if this is changing over time or how it will ultimately affect their viability”.

Orcas, in addition to the essential role they play in marine ecosystems, are highly prized for their cultural and spiritual significance to coastal tribes and communities in the Northeast Pacific and for being a top attraction for the ecotourism industry (NMFS 2014). Resident orcas—particularly the southern resident population—clearly face an uncertain future. Of particular concern to both resident populations is the availability of their preferred food source, as many Chinook salmon populations in the Pacific Northwest have experienced substantial declines from historic numbers. Ensuring adequate prey availability cannot be solved with simple actions but will require a long-term commitment to restoring depleted salmon stocks (NMFS 2014). Moreover, due to the interconnected nature among resident orcas and their prey populations, a multispecies approach is an essential step towards effective management of both salmon stocks and orca recovery efforts. There are also major knowledge gaps with respect to diet and distribution of resident orcas during the winter and spring that require further investigation (DFO 2016). In particular, it is important to determine which Chinook and other Pacific salmon stocks are consumed by resident orcas at different times of year and in different geographical locations (DFO 2010). Although addressing prey availability is an essential component of effective recovery strategies targeting resident orcas, long-term population recovery will require a combination of actions targeting all known anthropogenic threats to this iconic marine mammal (M. Ford, pers. comm.).

There is now a heightened urgency to focus recovery efforts on endangered southern resident orcas—a population that faces a significant number of threats due to their small population size, dependence on the industrialized waters, and pressures of living side by side with a high number of human populations around the Salish Sea.

Acknowledgments
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References
DFO (Fisheries and Oceans Canada). 2016. Action plan for the northern and southern resident killer whale (Orcinus orca) in Canada [proposed]. Species at Risk Act Action Plan Series. Fisheries and Oceans Canada, Ottawa. 32 pp.
Ford, J.K.B., G.M. Ellis, L.G. Barrett-Lennard, A.B.


Biological Monitoring of Key Salmonid Populations: Steelhead Trout in British Columbia

By William Stanbury
2016 NPAFC Intern

In the angler’s paradise that is British Columbia (BC), Canada, there lives a fish renowned for its elusiveness and fighting ability. Amid old growth forests, interior valleys, and urban centres alike, this torpedo-shaped anadromous trout is truly unique, as it is iteroparous, spawns in the spring, and sexually matures at two to ten years (potentially up to six-year smolt and four years at sea), and may live to 11 years, nearly double the lifetime of other Pacific salmon species (NOAA 2016). This fish is most identifiable to anglers by its slender body, large tail, and distinct spawning colouration (Figure 1) that turns its body a dark olive to silvery white, containing numerous black spots with a distinctive pink to red line along its side extending over the operculum (NOAA 2016; Figure 2). This is the mysterious steelhead trout (Oncorhynchus mykiss).

Steelhead, the anadromous form of rainbow trout, are native to Pacific coastal streams of Canada, the Russian Federation, and the United States of America (Figure 3). In North America, steelhead traditionally spawned from Bristol Bay, Alaska, to Baja California in northern Mexico (Burgner et al. 1992). However, recent studies suggest that the range is shrinking, with southern California populations rapidly heading towards extinction, possibly in as few as ten generations (Katz et al. 2012).

In BC, steelhead have access to almost 27,000 km of coastline with ancestral streams existing in an estimated 391 coastal watersheds that include 430 stocks and three ecotypes (Bison 2008; Beere 2016; BC FLNRO 2016a). The easternmost distribution is defined by coastal watersheds (Figure 4). Major steelhead producing systems in BC include Vancouver Island, Haida Gwaii, and the Fraser, Thompson, Dean, Skeena, and Nass rivers (BC MOE 2015, 2016b; Figure 5).

In the spring, after rearing in BC streams for one to six years (Ward and Slaney 1988; DFO 2013), steelhead smolts begin their migration into the North Pacific where they can be found in their greatest concentrations between 42°N and 52°N latitude (Burgner et al. 1992). In summer, BC steelhead migrate westward in the ocean and have been identified in the western North Pacific by coded wire tag and disk tag recoveries. Some BC steelhead have been located far to the westward, less than 1,000 km from the Russian city of Petropavlovsk-Kamchatsky (Myers et al. 1996; Figure 6).

After spending one to four years in the North Pacific Ocean (Ward and Slaney 1988; Beacham et al. 2012; DFO 2012) steelhead return to natal streams to spawn in two broadly defined runs; these are known as summer-run and winter-run steelhead (BC FLNRO 2016a). The number of steelhead that spawn multiple times is highly variable and...
some may spawn as many as eight times (Russian populations). In one study completed by Ward and Slaney (1988) on the Keogh River (the only long-term counting fence facility providing a direct measure of marine steelhead survival in BC), it was discovered that over a 10-year period (1976–1986) roughly 8.1% of male and 11.6% of female steelhead were repeat spawners. In some systems, up to 20% of steelhead return to spawn a second time (DFO 2013).

Ecotypes and Life History

In BC there are roughly 430 unique, demographically independent steelhead stocks (Beere 2016) that developed from three major phylogenetic groups. Steelhead stocks in southern coastal regions of BC were colonized from a glacial refugium in present day coastal Washington State at the end of the last glacial period. Southern interior stocks were colonized from the Columbia River watershed. Steelhead in northern BC are decedents of fish from a number of coastal refugia, including Haida Gwaii, that remained ice-free during the last glacial period (Bison 2008).

Coastal summer steelhead are sparsely distributed on the south and central BC coast and generally belong to small, unproductive stocks that time their freshwater entry with spring-runoff.

Steelhead of the interior summer ecotype are typically found overwintering in large systems, but may spawn in very small (less than 2 m wetted-width) streams with varying stock productivity. These steelhead begin their freshwater migration from mid-summer to late fall. Once in freshwater, both coastal and interior summer-run ecotypes have a residency period of 7–10 months before spawning in spring (BC FLNRO 2016a).

Coastal winter steelhead are the most common ecotype on the BC coast and normally spawn in small and unproductive systems. Freshwater entry of adult fish is highly variable as rainfall and snowmelt regimes dictate run-timing. Generally, southern stocks begin freshwater migration from October to March while northern stocks begin migrating from October to June. Winter-run steelhead enter freshwater at a more advanced stage of maturity (when compared with summer-run steelhead) and have a relatively short freshwater residency period before spawning (BC FLNRO 2016a).

Due to their run-timing, summer-run ecotype steelhead can be susceptible to being caught as by-catch in commercial salmon fisheries. For example, interior Fraser River adult steelhead migrate at the same time as commercial chum salmon gillnet fisheries are conducted, exposing steelhead to the risk of capture. Therefore, federal and provincial managers work together to minimize steelhead casualties by forecasting salmon run-timing and delaying the chum salmon fishery to allow for safer passage of steelhead (DFO 2016).

Despite the wide distributional range of steelhead and cooperation among fishery managers to prevent by-catch, steelhead are not abundant, with many stocks occurring in small coastal watersheds that support less than 10,000 smolts (Beere 2014). Many provincial stocks produce less than 500 adults and only a few dozen streams produce 1,000 adults or more (BC FLNRO 2016a). In total, BC is home to roughly 340,000 wild adult steelhead salmon (Beere 2014).
Figure 3. Freshwater and coastal distribution of steelhead trout in countries adjacent to the North Pacific Ocean. Map created by the National Marine Fisheries Service, Office of Protected Resources NOAA (www.nmfs.noaa.gov/pr/pdfs/rangemaps/steelheadtrout.pdf).

Figure 4. Freshwater distribution of steelhead trout in British Columbia. Freshwater distribution of steelhead outside of British Columbia is estimated.
and First Nations with the intention of maintaining and enhancing the quality of experience associated with the recreational steelhead fishery in the Skeena region. One such restriction prohibits non-Canadian residents from angling on weekends from September 1 to October 31 on the Bulkley, Telkwa, Kispiox, Morice, Babine, and Suskwa rivers (BC FLNRO 2013, 2016b). Along with non-Canadian resident restrictions, local anglers benefit from their resident priority, which qualifies them for reduced licensing fees and unlimited access to Classified and Limited Entry waters (BC FLNRO 2016a).

Angling opportunities exist in all steelhead-producing systems at almost any time of year. Since 1967, the most popular steelhead angling region in BC has been the Lower Mainland, followed by the Skeena, Vancouver Island, Thompson, and Caribou regions (Steelhead Harvest Analysis data as sourced in Beere 2014). In 2013, the five most fished steelhead rivers in BC were the Chilliwack, Bulkley, Skeena, Cowichan, and Alouette rivers. The Chilliwack River was the busiest river in the province amassing almost 50,000 angler-days in the 2012/13 season alone (Steelhead Harvest Analysis data as sourced in Beere 2014).

Despite a vibrant sport fishery, there is no commercial fishery for steelhead in BC.

Legislation and Management
Steelhead are the only species of Pacific salmon not managed by Fisheries and Oceans Canada (DFO), the lead federal body responsible for managing salmon fisheries in Canada. Administration of the steelhead fishery in BC was designated a provincial responsibility in the early 20th century but was formalized in the federal Fisheries Act of 1985. The BC Sport Fishing Regulations (last amended in 2010) serve as the current laws that govern recreational freshwater fisheries. Steelhead are managed at provincial, regional, and river-specific levels by the Allocation of Angling Opportunity Policy, Steelhead Stream Classification Policy, and Provincial Framework for Steelhead Management in BC (BC FLNRO 2016a), and by both regional and river-specific management plans.

In 2016 the Provincial Framework for Steelhead Management in BC was developed to provide an overarching provincial approach to steelhead management. The primary goal of this framework is to ensure an abundance of wild steelhead populations at levels that will produce societal benefits now and for future generations of British Columbians. To ensure productive and abundant steelhead populations, BC works to conserve steelhead stocks and habitat, actively manages populations in response to change, uses the precautionary approach in management when uncertainty exists, and minimizes management impacts on vulnerable by-catch species. Pursuant to conservation goals, the province manages the recre-
The recreational fishery for wild steelhead in BC is strictly a catch and release fishery (BC FLNRO 2016a, b).

Since 1997, BC permits anglers to fish virtually any steelhead river in the province, but prohibits retention of wild steelhead salmon in all fishery management regions.

Although no wild steelhead may be retained by anglers, BC hatcheries have been producing retainable steelhead since the early twentieth century. Steelhead hatchery programs have implemented practices consist-
tent with recommendations from various hatchery reform reviews including: the use of only wild broodstock, random selection of broodstock, a maximum 1:1 hatchery:wild ratio in catches, and the release of smolts at down-river sites. To ensure anglers know which steelhead are hatchery produced, and thus harvestable, hatchery fish are marked by removal of the adipose fin (Pollard 2013).

In 2005 the province, recognizing the demand for retention angling opportunities yet mindful of potential damage...
to wild stocks, developed the Steelhead Stream Classification Policy (SSCP) to manage the risks of hatchery-augmentation in order to maintain healthy, self-sustaining, wild steelhead stocks (BC FLNRO 2016a). With the development of the SSCP came the introduction of “wild” and “hatchery-augmented” streams, marking a definitive difference between a stream that receives hatchery steelhead and one that does not. As of 2005, hatchery-augmentation of wild steelhead populations may only occur on hatchery-augmented streams; streams where a traditional steelhead population is extirpated, not sufficiently abundant, or never existed (BC FLNRO 2016a). From 2006 to 2012, 11 fry and 14 smolt stocking programs took place annually in BC streams (Beere 2014). During 2012 and 2013, steelhead hatchery programs operated on 13 streams across BC (Figure 8) in federal, Freshwater Fisheries Society of BC, and community-run hatcheries (Pollard 2013; Table 1). As of 2016, there are roughly 13 hatchery-augmented streams in BC (Tompkins et al. 2016) and of the 13, 12 have smolt release programs that release annually a total of about 400,000 smolts. There is currently one fry-release program in BC that releases roughly 10,000 fry per year (Tompkins et al. 2016).

In hatchery-augmented streams, anglers may retain as many as 10 hatchery steelhead per year with a daily quota of up to four (BC FLNRO 2016b). When a hatchery steelhead is retained, anglers must immediately record the catch on their angling licence. After retaining their daily quota of hatchery fish, anglers must immediately stop fishing for steelhead (BC FLNRO 2016b).

### Licensing and Restrictions

To legally fish for (and retain) steelhead in BC, anglers must purchase a basic angling licence with a conservation surcharge stamp. There are three basic licenses for freshwater fishing in BC: a one-day, eight-day, and an annual licence. When purchasing a licence the province of BC

<table>
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<tr>
<th>Basic licences</th>
<th>BC resident</th>
<th>Non-resident</th>
<th>Non-resident alien</th>
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### Stock Ecotype

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<td>Hatchery</td>
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Table 1. Steelhead smolt releases from hatchery programs in British Columbia during 2012 and 2013. Stock ecotype refers to the timing of adult return to freshwater. Smolt releases are in numbers. FFSBC refers to the Freshwater Fisheries Society of British Columbia. Table adapted from Pollard (2013).

Table 2. The costs associated with purchasing a basic angling licence, a conservation surcharge stamp, and a Classified Waters licence in British Columbia based on the provincial definition of angler resident status.
Figure 9. Relative abundance changes in steelhead populations when compared with the previous decade in British Columbia. Green areas indicate increased abundance over the previous decade and yellow areas indicate no significant change in abundance. Red areas indicate lower abundances when compared with the previous decade. The bottom-most map represents a sixteen year period spanning from 2000 to present. These maps were created by amalgamating data presented by Beere (2014) and the Steelhead Harvest Analysis (presented in Beere 2014). Ranges are approximated and are meant as a general representation of regional changes over time.
identifies the angler as a BC resident, a non-resident, or a non-resident alien and charges fees accordingly. British Columbia residents are defined as individuals who have a primary residence in BC, are a Canadian citizen/landed immigrant, and have been physically present in BC for the greater portion of each of six calendar months of the preceding 12 calendar months. An angler will also qualify as a BC resident if they are not a Canadian citizen/landed immigrant, but have been physically present in BC for the greater portion of each of the preceding 12 calendar months. The province defines non-residents as anglers who don’t qualify as a BC resident but are a Canadian citizen/landed immigrant, or have a primary residence in Canada and have resided in Canada for the preceding 12 months. An angler is considered a non-resident alien if they do not qualify under the other two definitions (BC FLNRO 2016b; Table 2). To fish Classified Waters, which are rivers deemed to be of exceptional quality in both surrounding and fishing, anglers must purchase a steelhead stamp in addition to possessing both a basic angling licence and a conservation surcharge stamp (BC FLNRO 2016b).

Along with licensing, seasonal and area closures are tools used by provincial and regional managers to protect steelhead salmon at critical junctures while still providing angling opportunities. For example, Thompson River steelhead belong to stocks with low abundance and managers only open the fishery when run strength exceeds (or is expected to exceed) a minimum threshold (BC MOE 2000). Likewise, in the Caribou region, fishing bans are in effect on streams in the Fraser River watershed (except Fraser main stem) from April 1 to June 30 in response to declining steelhead abundance (BC FLNRO 2016b). Temporary and seasonal closures provide steelhead with a respite from angling pressures and ensure a fishery for future anglers.

In all freshwater fisheries anglers must abide by gear-type restrictions when fishing for steelhead. All anglers in all regions must use a single barbless hook and the use of bait for summer-run steelhead is prohibited (BC FLNRO 2016b). Bait-bans are put in place to lessen the incidence of lethal bleeding from the hooking wound and provincial managers have targeted this ban for interior stocks specifically because of low population levels (BC FLNRO 2016c). A bait-ban is also in effect for rivers where the possibility of by-catch of other trout and char species is increased (BC FLNRO 2016a).

**Abundance Patterns**

The abundance of steelhead across BC has varied significantly over both time and space and, although it is difficult to accurately describe every stock as part of a larger abundance narrative, there has been notable shifts in steelhead abundance over the past 40 years. A shift in ocean climate during the late 1970s prompted a dramatic increase in steelhead in many southern streams across the province during the 1980s (Welch et al. 2000), including those on Vancouver Island (Heber, Tsitka, Englishman, and Keogh rivers), the Lower Mainland (Little Campbell River), and the Interior Fraser (Chilcotin and Thompson rivers; Beere 2014). Furthermore, a comprehensive assessment of steelhead harvest analysis data completed by Ahrens (as sourced in BC FLNRO 2016a) indicated that many steelhead stocks north of the Bella Coola and Dean rivers also improved in status during this time period. In general, steelhead stocks increased in size (with some southern stocks doubling in size) during the 1980s (Figure 9). This high abundance pattern eventually gave way to significant declines during the 1990s, with many southern stocks identified as extreme conservation concerns (BC FLNRO 2016a).

The decade prior to the millennium was one characterized by significant, yet uneven (Welch et al. 2000) declines in provincial steelhead stocks. During this period, eastern Vancouver Island contained the most stocks in decline and marine survival of wild steelhead salmon as measured at
the Keogh River fell to less than 5%, compared with a peak of 25% a decade prior (BC FLNRO 2016a; Figure 10). In 1996, one study conducted by Slaney et al. suggested that roughly 1% of stocks in the Georgia Strait and Lower Fraser River were at high risk of extinction, while an additional 16% were of special concern. In central BC, steelhead escapement on the Dean River dropped from 1980 abundances, yet remained higher than yearly escapement in the latter 1970s (Beere 2014). Northern stocks, as typified by the Skeena and Sustut rivers, either returned to abundance levels seen prior to the 1980s surge, or remained generally stable (Hirshfield 2011; BC MOE 2016a).

The decline of steelhead populations ceased at the turn of the century and stocks have generally remained at 1990s abundances or increased. Since 2010, there are indications that several stocks are recovering from low abundance patterns. Significant increases in steelhead abundance have been recorded on Vancouver Island (Tsitika, Cowichan, Heber, Gordon rivers) and in the Lower Mainland (Silverhope, Coquihalla, Cheakamus, Alouette, Coquitlam rivers) (BC FLNRO 2016a). Despite this recovery, many Vancouver Island and central BC stocks remain at record, but stable, lows. These systems include the Englishman, Keogh, Thompson, Chilcotin, Bella Coola, and Atarko systems (BC FLNRO 2016a). Some populations, including the Thompson Interior Summer Ecotype, continue to decline in abundance. On the Skeena River, yearly escapement has exceeded 20,000 individuals in fourteen of the past sixteen years, whereas escapements of comparable size have been met in only five years in the decade prior (BC MOE 2016b). Similarly, the Sustut River, a tributary of the Skeena, measured a higher abundance of returning steelhead in 2016 than any year since 1994, rebounding from historic lows reached in 2006 (Hirshfield 2011; BC MOE 2016b). Further north, on the Nass River, steelhead populations have remained relatively constant since the early 1990s (Beere 2014).

The Future
Steelhead trout in BC face an uncertain future and, while signs of stock recoveries exist, many persist at record lows. Climate change, habitat loss, incidental by-catch from commercial salmon fisheries, and angling pressures are but some of the issues facing these fish today. Yet, despite these challenges, there is reason for optimism. Steelhead population declines that were prevalent in the 1990s have all but ceased, a new provincial framework has been put in place to actively protect endangered stocks, and steelhead anglers themselves have led the charge for population conservation. Furthermore, efforts have been made to bridge the gap between provincial and federal management bodies in an attempt to better coordinate commercial fisheries to limit by-catch of steelhead trout. These efforts, designed to protect the steelhead fishery in BC, will undoubtedly positively affect steelhead populations over the next several decades.

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References


View of lighthouse taken from a whale watching boat in Victoria, BC. Photo credit: Tourism Victoria.
Ecology of Salmonids in Estuaries Around the World—Book Review

By Jim Irvine

Pacific Biological Station, Fisheries and Oceans Canada

“My intent in writing this book is to introduce and orient present and future researchers, students, and practitioners to the study of salmon conservation in estuaries.”

So begins the preface to the recent book on the ecology of salmonids in estuaries by retired research scientist, Colin Levings. Born and raised in British Columbia, Levings spent most of his career with Fisheries and Oceans Canada at the Centre for Aquaculture and Environmental Research in West Vancouver. Although his research interests are broad, salmonids and estuarine ecosystems have always been an area of particular interest to Levings. As indicated in the book’s preface, the role of salmonid habitats and how they confer fitness for survival has been much less studied in estuaries than in rivers or oceans, and a comprehensive review of estuarine habitats used by salmonids was lacking prior to this book being published. The book includes information from 196 estuaries from around the world. In addition to 19 chapters, the book has a useful glossary, an extensive list of references, and a convenient index. As well, five appendices are available on-line at hdl.handle.net/2429/57062, including a primer on estuaries aimed at citizen scientists.

Levings identifies three ecophysiological concepts important in determining survival fitness in estuaries: (1) successfully changing from fresh to salt water; (2) obtaining a growth advantage as food is often more abundant in an estuary than a river; and (3) biotic interactions including refuge from predators. He provides evidence for these concepts throughout the book, and describes differences among species in the importance of each concept.

After setting the stage in Chapter 1 by describing some of the roles that salmonids and estuaries have played in human civilization, Levings identifies the three primary advantages of residency in estuaries as: (1) osmoregulatory adjustments; (2) benefiting from increased food availability; and (3) postponing increases in predation or competition risks. In the next chapter he reviews the salmonid species and life history stages that rely on estuaries. Chapter 3 describes the unique physical and chemical characteristics of estuaries that differentiate them from rivers and oceans. Adjusting to changing salinity along the course of an estuary is perhaps the biggest challenge faced by salmonids during their life cycle. Chapter 4 describes a framework for the description of estuarine habitats, including important estuarine water properties. The next chapter overviews salmonid communities in estuaries around the world, and documents the role people have played in extending the distribution of salmonids. In Chapter 6, various sampling approaches used to determine the abundance and distribution of salmonids in estuaries are described; the common beach seine will
likely continue to be the standard sampling approach, but new and developing methods including electronic tags and parasite and genetic marks have shown much promise.

Chapters 7 and 8 describe salmonid behaviour (migration, holding and residency, cover-seeking, feeding, schooling, homing, and spawning) and growth, respectively. Most of our understanding of behaviour has been obtained by tracking tagged fish and there are lots of opportunities to improve our understanding with electronic and other tags. Smolting and osmoregulation for smolts, returning adults, and kelts are reviewed in Chapter 9. In Chapter 10, Levings describes salmonid food webs in the context of estuarine habitats. He also describes important characteristics of prey that support rapid salmonid growth, and possible food gradients in food quality. In Chapter 11 he examines the top-down (field and analytical) control mechanisms, predation and competition, and documents the significant influence predation can have on smolt survival. Chapter 12 documents the many and varied effects that humans have had in salmonid estuaries, ranging from habitat loss and pollution to changes in communities resulting from invasive species. In general, degradation of salmonid estuaries is correlated with human population density.

In Chapter 13, Levings reviews the various approaches (field and analytical) used to estimate survival of salmonids in estuaries, including fitness components of survival. Perhaps not surprisingly, the number of studies that have successfully estimated survival is limited. In Chapter 14, he discusses how human-induced changes in estuaries can affect the three key fitness components of survival: osmoregulatory adjustment, growth, and biotic interactions. Salinity and water quality changes can compromise the successful completion of osmoregulatory adjustment, habitat-related food deficits can reduce estuarine salmonid growth, and habitat loss and ecological community changes can affect biotic interactions, for example predation and competition.

In Chapter 15, the author reviews how salmonids contribute to ecosystem services, in particular fish harvesting and aquaculture, and comments on the current status of these services in select estuaries. Chapter 16 is a review of the role of disease and parasites on the health and survival of salmonids in estuaries. In Chapter 17, Levings describes key attributes of salmonid estuaries and various indicators of estuarine quality, including fish assemblages with salmonids.

Future considerations for conservation of salmonids in estuaries are reviewed in Chapter 18. Strategies to conserve salmonids and their estuarine habitats include spatial planning, marine protected areas, and restoration. Because estuaries are part of a continuum, it is important to consider stressors that originate upstream and in the freshwater portion of an estuary, in addition to the estuarine-specific stressors. The final chapter is entitled Conclusion, and is aimed primarily at researchers working on estuaries. This chapter provides a useful listing of the author’s recommendations for areas of focus for future research on salmonid estuaries.

I recommend that those studying estuaries consider purchasing this reasonably priced book. It provides a comprehensive review of what is known about salmonid estuaries, as well as recommendations for future work. However, I have some minor quibbles with the book. For instance, the importance of fitness was identified early on in the book, but it was described in somewhat different ways in several sections of the book, rather than being adequately described early on. I welcomed the author’s efforts to draw connections among the various chapters in the concluding paragraph of many of the chapters, but wondered if several of the chapters might have been merged. I very much appreciated the individual conclusion section for each chapter, as well as the final Conclusion Chapter, which should help guide future research. Finally, recognition of the increasing role of citizen scientists, and special text in the on-line appendix to help orient these individuals, is to be commended.

We owe a debt of gratitude to Colin Levings for the time and effort he spent producing this valuable review of the ecology of salmonids in estuaries.
Fishery Science for Tomorrow—PICES 25th Anniversary from the Viewpoint of NPAFC

By Vladimir Radchenko
Executive Director, NPAFC Secretariat

In the early 1990s, when I began to participate in international scientific workshops in North Pacific Rim countries as a fishery science researcher, I encountered and read the book, *Fish for tomorrow*, by John D. Gilbert, a Professor at the University of Washington. This book is devoted to the origins of the International Pacific Halibut Commission and, in a more general sense, to the fisheries community’s increased awareness of the fundamental importance of international treaties for straddling fish stock conservation and management in the past century. Certainly, this book allowed me to better understand the mechanism for implementing international treaties.

As it might seem from the outset, all international treaties for straddling fish stocks are about how to split resources among several competing parties, and the people involved in working within the framework of these treaties know that coordinated fish stock management is not like sharing a meal. The effectiveness of international treaties and related agreements is not solely based on limiting fishing capacity and vessel usage. While these legal instruments provide an important framework for information exchange, combining efforts in mutual scientific research, and development of comprehensive understanding on factors affecting stock dynamics and conservation measures, the main principle of an international treaty should be to unite (people, institutions, resources, efforts, and knowledge) rather than to divide. It is when there is a mutual commitment to join efforts and resources for the common goal that such a framework will be most successful.

The 25-year history of PICES (North Pacific Marine Science Organization) is fortunately well documented. Two books by Sara Tjossem, *The journey to PICES: scientific cooperation in the North Pacific* (2005) and *Fostering internationalism through marine science* (2017) present the PICES chronicle with concise details. All factors driving for the formation of a new international organization are listed: a sharp increase of distant-water fishery harvest in Pacific waters after Second World War, pushed by technological progress in shipbuilding, mechanics, and hydroacoustics; followed by the necessity to constrain the freedom of the sea in relation to distant-water fisheries; and negotiations...
to conclude a new fisheries treaty between leading fishery states. The first international convention was concluded in the North Pacific and established the International North Pacific Fisheries Organization (INPFC), the NPAFC predecessor, in 1952. However, since the early 1970s, states desired a different approach to establishing PICES. The main idea was to use ICES (International Council for the Exploration of the Sea) as a template for PICES, even as far as reflecting this in the new organization’s acronym—PICES—as Pacific ICES.

The ICES history sets a good example. It is the oldest regional fisheries management organization (RFMO), and it will soon celebrate its 115-year anniversary, having started in 1902 as a purely scientific society. It emerged based on the idea of hydrographer Otto Pettersson that herring fishery fluctuations could be explained by hydrography. That is why ICES’s objectives initially included “to promote and encourage research and investigations for the study of the Sea, particularly those related to the living resources thereof” (Jens Smed archive; ICES website, p. 52). Despite the ICES area of competence being first restricted by the northeastern North Atlantic and the Baltic Sea, there were many famous people among the ICES founders, who thought of a bigger picture. “Otto Pettersson’s obsession with the idea that oceanography in general, and fisheries oceanography in particular, was work not for the narrow waters but for the open sea, and in due time, for all oceans of the world was the key to bringing all these people [scientists, managers, and politicians] together because it forced him to overcome all the political and practical problems that arose. Brining people together to discuss common problems was the first and most important step ... to continued development of science within the ICES community” (Jens Smed archive; ICES website, p. 216).

One of the PICES founders, Warren Wooster, armed with his ICES experience as its President in 1982–1985, envisioned an ambitious scope for PICES. In December 1991, I was fortunate to attend the first PICES Scientific Workshop in Seattle that was held to review the state of knowledge in selected scientific fields and define scientific pillars for the future PICES program. As a strong supporter of the ecosystem approach in fishery science, I was very positively surprised by the ecosystem-level considerations at the workshop. Session chairpersons guided participants to discuss all agenda items based on ecosystem status and trends. At the workshop, scientists paid thorough attention to climate change and environmental quality issues as well as to fishery oceanography. Hereafter, climate change became a major item of the PICES Strategic Plan and its first scientific program on Climate Change and Carrying Capacity (CCCC Program), and environmental quality research was organized under an umbrella of another scientific committee.

Summarizing PICES scientific activities in 2002 after its first ten years, Warren Wooster wrote: “In its first decade, PICES considered a wide array of problems, including those of specific regions, such as the Okhotsk Sea and Oyashio region, the Bering Sea, the subarctic gyre, and the Japan/East Sea; circulation modeling, carbon dioxide, and the iron fertil-

With establishment of the CCCC Program in 1995, the scope of PICES scientific interests quickly expanded. Three task teams—on regional experiments, on basin-scale studies, and on conceptual/theoretical and modeling studies—were organized in 1995. Four permanent scientific committees created new working groups at each annual meeting. Then, new elements (one more technical committee, advisory panels, and study groups) emerged in the PICES organizational structure in the late 1990s–early 2000s. The average number of PICES annual meeting participants increased from 230 in 1992–1999 to 430 in 2000–2009. Reporting on the 8th PICES Annual Meeting, which our TINRO-Center team organized in Vladivostok, I remarked that growth of the number of PICES annual meeting participants closely correlated with progression of warming of the World Ocean (e.g., increase of the heat budget of the upper 700-meter layer). Primarily, it was due to the increasing awareness among scientists of

Correlation between the World Ocean heat content at 0–700 m depth (U.S. Environmental Protection Agency, Climate Change Indicators in the United States: data by NOAA) and the number of PICES annual meeting participants, 1992–2016.

Sara Tjossem presents her new book Fostering internationalism through marine science (2017) to George Hunt, a multi-year leader of marine bird and mammal science in PICES and one of the ESSAS founders. Photo credit: Oleg Katugin, TINRO-Center.

Alex Bychkov, PICES Executive Secretary 1999–2014, receives the PICES Chair Award from Laura Richards, PICES Chair 2012–2016. Photo credit: Oleg Katugin, TINRO-Center.
climate change impacts on the sustainability of fisheries and aquaculture. The second reason I mentioned for the growth in PICES meeting participants was in jest: according to the well-known law of physics, particles in any system begin moving faster with temperature growth. In 2000, the correlation coefficient between the number of annual meeting participants and ocean heat budget reached 0.89 but, even now, the correlation has remained strong (r = 0.75). This is evidence that scientific thoughts are still boiling in the PICES community.

Practically, every scientist, whether he/she was a physicist, mathematician, or chemist, not to mention marine biologist, has found their own way to be involved in the PICES research process. Having said this, I should emphasize that all these numerous structural bodies and their scientific projects and programs did not take on lives of their own within the organization and did not remain clustered like pomegranate seeds in a rind. Figuratively speaking, PICES digested them, transformed them into useful “bricks” of its own structure, and in-built them as gears in a clock movement. The credit for this goes largely, and ultimately, to the PICES Secretariat and chairpersons. Alexander (Alex) Bychkov, who started his work as the Assistant Executive Secretary in 1996, led the Secretariat’s functioning in 1999–2014. In 2016, he was awarded by the newly established PICES Chair Award, and the whole Opening Session audience stood up spontaneously to honour Alex for his dedicated 20 years of work for PICES. In my understanding, his exceptional ability to manage confidently this “controlled blast” of PICES activities deserves recognition in the first turn. In that connection, I wish to quote Manuel Barange, GLOBEC Executive Director, who wrote in Tjoosm’s second book: “I have always been impressed by the achievements of the PICES Secretariat: helpful, flexible, responsive, and dynamic, with ambition that exceeds expectations”.

It should be said that not all fishery scientists, who were involved in PICES activities in the early years, completely endorsed the organization’s expansion of scope around and above the horizon of “regular” fishery science. Some of them thought that fishery science was under-represented in PICES and its profile should be increased and activities be expanded (Hay et al. 2002, Ten years Fis in PICES: An introspective, retrospective, critical and constructive review of Fishery Science in PICES. PICES Sci. Rep. 22: 43–53). This was especially noticeable when comparing the structure of ICES and PICES. In the early 2000s, ICES consisted of seven standing scientific committees including only one oceanographic committee, while PICES had a single Fishery Science Committee (FIS), two oceanographic (biological and physical oceanography, BIO and POC) committees, and one marine environmental quality committee (MEQ). As a consequence, available session time at the PICES annual meetings was distributed nearly equally among the committees, despite that fisheries matters always appeared to be a prominent justification for the initial developments of PICES (Wooster, W.S. and Callahan, M.M. 1994. The PICES papers. Reports
of meetings leading to the establishment of the North Pacific Marine Science Organization (PICES), 1978–1992. PICES. 143 pp.).

In those years, I was a member of FIS and agreed for the most part with these concerns. However, I was sure that the successful future of fishery science in PICES was not in preferential sharing of available session time, Science Board seats, and/or financial resources to cover journal page costs. Instead, the road to a successful future would be found in developing inter-disciplinary research projects between fishery science and other scientific disciplines.

Together with other PICES Science Board members, we acknowledged the formation of the first inter-committee (FIS and MEQ) working group in 2003, the gradual increase of topical inter-disciplinary publications in primary scientific journals and the PICES Scientific Report Series, and the development of inter-committee cooperation in organizing annual meeting sessions. As for sharing annual meeting time, there were eight of 12 scientific sessions co-sponsored by two-to-four standing committees at the 2016 PICES Annual Meeting in San Diego. Whereas ten years earlier, only one committee sponsored eight of 12 scientific sessions at the 2006 PICES Annual Meeting in Yokohama. As for inter-disciplinary publications, two North Pacific Ecosystem Status Reports (PICES Spec. Publ. 1, 2004; PICES Spec. Publ. 4, 2010; available at www.pices.int) encompassed all previous scientific collective papers and provided readers with comprehensive overviews of North Pacific marine ecosystems. I was glad to hear that preparation of the third North Pacific Ecosystem Status Report is in progress, and that the NPAFC Pacific salmonid catch and hatchery release data, the result of transfer and update of information from NPAFC yearbooks completed in 2014, may be good sources of fishery data for comparisons with environmental conditions.

After almost simultaneous establishment, NPAFC and PICES became “natural partners” (Tjossem 2017) in the North Pacific region. Relative proximity of the headquarters, similar incentives, and wide overlap of convention areas, states membership, and experts involved in both organizations’ activities made this partnership tight and close. In 1998, our organizations signed a Memorandum of Understanding to regularly exchange information, maintain reciprocal consultations, and coordinate meeting scheduling. Joint programs and activities were mentioned as possible ways in which cooperation between NPAFC and PICES can be further expanded. Afterwards, joint activities were not long in coming. In 2000, PICES organized the Beyond El Niño international conference on Pacific climate variability and marine ecosystem impacts that was co-sponsored by the NPAFC. It was an opportunity for many salmon scientists to present at the conference and, then, continue meeting in La Jolla for the NPAFC scientific research and planning coordination meeting the following week. The same year, PICES co-sponsored the first in a series of NPAFC juvenile salmon workshops, Factors
Affecting Production of Juvenile salmon, in Tokyo. In total, NPAFC and PICES have organized or co-sponsored four of seven major scientific symposia and five workshops in the NPAFC’s 25-year history. Outcomes of these symposia were published in the NPAFC Bulletin and such primary journals as *Progress in Oceanography* and *ICES Journal of Marine Science*.

In June 2013, NPAFC and PICES established the joint Study Group on Scientific Cooperation in the North Pacific Ocean with a one-year term. Libby Logerwell (PICES FIS Chairperson) and Jim Irvine (Chairperson of the NPAFC Working Group on Stock Assessment) led the Study Group. The Terms of Reference of this group included such important tasks as development of a framework for cooperation between NPAFC and PICES that lists categories of joint activities and the rationale for each, including the benefits to each organization from the joint activity, and identification of priorities for joint activities within categories. In 2014, the *Framework for Enhanced Scientific Cooperation in the North Pacific Ocean* (available at www.npafc.org) was endorsed and signed by both organizations. The framework identified two major scientific topics of common interest to NPAFC and PICES: (1) effects of climate change on the dynamics and production of Pacific salmon populations; and (2) oceanographic properties and the growth and survival of Pacific salmon. PICES became the first and sole organization with which NPAFC collaborates at such high level of confidence.

When, in 2003, the United States submitted a formal request for advice to PICES to review possible implications of the 1998 regime shift for North Pacific fisheries, it was an official recognition of fishery science rank within the PICES community. The report (*King, J.R. 2005. Report of the Study Group on the Fisheries and Ecosystem Responses to Recent Regime Shifts. PICES Sci. Rep. No. 28, 162 pp.*) was promptly compiled by a vigorous team of PICES scientists, and it also set an important benchmark in fishery management approaches. The report was the first to introduce the practicability of the regime shift concept at the international level. Despite that climate change and its consequences for marine ecosystems and resource management were frequently the topic for diverse scientific papers, fishery managers still believed fishery resource conservation meant preserving the status quo in fishery ecosystems and fish stocks. PICES recommended a provisional stepwise approach to changing fishery harvest rates with associated regime shifts and an advanced stock assessment approach that should include various recruitment assumptions, depending of the regime phase, and application of alternate harvest strategies. This recommendation was widely implemented in the PICES member countries. As an example, the U.S. National Marine Fisheries Service recently revised the National Standard 1 guidelines of the Magnuson-Sta-
vens Fishery Conservation and Management Act to reflect advances in fishery science and address a range of issues including advancing ecosystem-based fisheries management. The revised guidelines emphasize that managers should consider the broader marine ecosystem when managing fish populations. By considering the ecosystem in fishery management, fishery science obtained greater recognition and gained significant incentive for further development, which would not have been possible to reach on a single species basis and without reflection on habitat conditions.

“The careers of many young scientists would not have been as successful without PICES”. I completely echo this sentiment by Manu Di Lorenzo, POC Chairperson-elect. Seven years of my early career, I worked as a practical ichthyologist on research vessels, sailed seas Pacific-wide, encountered more than a thousand fish and squid species, wrote simple cruise reports, and considered field biologists like myself to be “foot soldiers of natural history”—the most skilled, wise and diligent players of research teams in marine expeditions. Then, two years after joining the Laboratory of Applied Biocenology at TINRO, my lucky encounter with real fishery scientists using an ecosystem approach in fisheries research, including my mentor Professor Vyacheslav Shuntov and then with the PICES community, further defined my scientific good fortune.

Attendance at 20 of 25 PICES annual meetings and a dozen symposia and workshops gave me an opportunity to give 26 talks, including the keynote lecture at the 2005 Annual Meeting in Vladivostok, ten posters, co-author 23 scientific articles and book chapters, and to participate in scientific discussions on myriad issues of current concern for fishery science. My work on different PICES subsidiary bodies, including six working and study groups, three committees, one advisory panel, Science Board, and Governing Council, gave me priceless experience and provided me with a broader perspective and a better understanding of fishery science in the framework of ecosystem-based management.
In September 2003, I was asked to represent PICES at the 26th SCOR (Scientific Committee on Oceanic Research) Executive Committee Meeting in Moscow. At this meeting, my report covered PICES cooperation with GLOBEC, ESSAS, JGOFS, SOLAS, work within frames of the GEOHAB and CLIVAR programs, and activities of a mutual working group and advisory panel. Preparing for this talk (honestly speaking it was mostly prepared by the PICES Secretariat) acquainted me with new organizations and programs. It was like reaching out to distant relatives that broadened my incentives by feeling part of a big marine science family.

Co-chairing the REX Task Team and chairmanship in BIO served to improve my administrative skills, and soon thereafter I accepted the proposal to lead the fisheries research institute on Sakhalin Island, a move that drastically changed the path of my scientific life.

Participation in PICES activities helped me to promote my own scientific ideas. Considering how to approach analysis of Bering Sea pelagic ecosystem dynamics, I noted that the general current pattern in the upper pelagic layer compiled by professional oceanographers varied in the 1960s–1990s. In the central part of the sea, the core element of water circulation—the major westbound current—was depicted either flowing in a straight latitudinal direction or flowing northwesterly along the continental slope and shelf edge, or in some intermediate position. Correspondingly, even the name of this current changed in scientific articles over time: from the Cross-Basin Current to the Central Bering Sea Current to the Bering Sea Slope Current. In the oceanographic literature, these distinctions were interpreted as inaccuracies due to lack of data and challenges in measurement.

Owing to the absence of data collected simultaneously for large marine regions, it was popular among Russian oceanographers to build a general current pattern by summarizing information based on a data series that was as long as possible. In the 1990s, many water circulation studies proudly proclaimed that the data series used summarized fifty years, or more. In contrast, although famous oceanographers had a point by using these long data series, I hypothesized each of them summarized their own study period, when position of the westbound flow varied based on the intensity of Pacific water inflow into the Bering Sea. I began to study atmospheric drivers of underlying ocean circulation but still could not explain the fluctuations of Pacific water advection into the Bering Sea. Physical oceanographers criticized my hypothesis, and one

of them commented, “Islands at sea are not able to move, therefore major sea currents will be stable in their positions forever”.

In starting to communicate with foreign colleagues in the PICES Working Group on the Bering Sea, I learned of Warren Wooster’s hypothesis on decadal-scale variability in the eastern subarctic Pacific (Wooster, W. S. and A. B. Hollowed. 1991. Decadal scale changes in the northeast Pacific Ocean. Northwest Environmental Journal 7(2): 361–363). The information started to come together all at once. I knew about decadal-scale variability in the north and south separation of the Subarctic Current at the west coast of North America was affected by climatic variability of atmospheric pressure fields. And it became clear to me why intensity of relatively warm Pacific water advection into the Bering Sea varied. Continuing analysis in this direction, I was able to properly ground my understandings on changes in the Bering Sea pelagic ecosystem during the 1989 regime shift. After publishing this idea, several marine biologists found explanations for the variability in the stock condition of their research subjects in the Bering Sea and began citing the paper, sometimes attributing this idea to...professional oceanographers. Nevertheless, the main thing is that the idea was implemented.

As a PICES scientist, I was happy to share many remarkable scientific projects with my colleagues worldwide, including journeys to ESSAS, NOWPAP, and ACIA. The Arctic Climate Impact Assessment (ACIA) initiative, which first published its report in 2005, was an excellent example of comprehensive multi-disciplinary assessments and forecasts of the consequences of climate change in the Arctic, including not only fisheries but also environmental, human health, social, cultural, and economic issues. I was so excited to participate in writing a chapter on fisheries and aquaculture for this 1042-page scientific report that, after electronic publication, I organized printing of five copies for libraries of Russian fishery research institutes. Now young scientists prefer reading scientific literature from a computer screen, and fortunately the ACIA report is still available at www.acia.uaf.edu/pages/scientific.html.

PICES helped to organize the activity of the North Pacific Research Board (NPRB). In 2003, the Science Board recommended me, as BIO Chairman, to the National Research Council (NRC) Study Committee to participate in writing the First NPRB Science Plan (NRC. 2004. Elements of a science plan for the North Pacific Research Board. National Academies Press, 140 pp.). This scientific document, drafted by our close-knit team of scientists and science managers in 2004, has remained topical and largely relevant for the second decade of NPRB activities.

In its turn, it is remarkable that the NPRB has notably assisted NPAFC in implementing the Commission’s science plans. The NPAFC appreciates the NPRB’s generous support for two scientific projects: Salmon Tagging in 2002–2003 and Genetic Stock Identification in 2003–2006. NPRB’s contribution has assisted in the invitation of salmon experts from NPAFC-member countries to the International Symposium on Pacific Salmon and Steelhead Production in a Changing Climate: the Past, Present, and Future in May 2015, held in Kobe, Japan, and to the Second IYS (International Year of Salmon) Scoping Meeting in Vancouver in March 2016. This looks to me like nice examples of how we can benefit in the future from our efforts in the past.

PICES has strongly promoted studies of climate change impacts on marine fish and fisheries. Several research projects devoted to this major theme laid a “highway of thinking” through the initial challenges in approaching an unknown domain. There are good reasons why the review article by Hollowed et al. (2013. Projected impacts of climate change on marine fish and fisheries. ICES Journal of Marine Science, 70: 1023–1037), written after the 2010 international symposium in Sendai which was co-sponsored by NPAFC and 20 other organizations, was so broadly discussed in scientific literature, including in an article in Science (Sydeman, W.J. 2015. Climate change and marine vertebrates. Science 350(6262): 772–777). In the first year after publishing, the Hollowed et al. 2013 paper quickly collected about 50 citations in primary journals and it is the first and has remained at the core of consideration of this research theme.

I heard many times that the PICES Secretariat staff does not like it when PICES is referred to as a RFMO. To be precise, the PICES vision and responsibilities expand much wider than any RFMO that focuses on particular highly migratory fish species like tuna or salmon. However, in my
opinion, PICES has its own “fish” to protect against unfavorable conditions.

This fish is fishery science itself that lives in the PICES Convention Area in a favourable environment comprising an array of developing marine scientific disciplines. Like many fish stocks, a fish called fishery science may suffer from climate change, especially with respect to political climate. Fishery science needs a stable “food” supply, i.e., research funding, without which it is at greater risk of dying. New ideas are a vivifying oxygen for this fish while scholasticism is a harmful environmental pollutant. Finally, it has its own “fisherman”—fishery management that utilizes a rich harvest of scientific knowledge but should also care about healthy stock conditions and prevent degradation of habitat, i.e., all marine sciences. In this sense, PICES is a true RFMO that follows the scientific directive on how to protect fishery science in the best possible way, together with its supporting ecosystem components. It is notable that the PICES acronym is consonant to the Latin word Pisces (fish).

Successful fishery management of fluctuating fish stocks should not be rigid, but instead be adaptive, flexible and supportive of change. In the same way, continued development is essential for the future of PICES. Despite that fishery science should remain a focal species of the “community of marine sciences” within PICES, it is important to recognize that fishery science can progress through coevolution with other scientific disciplines.

According to the Framework for Enhanced Scientific Cooperation mentioned above, improved collaboration should allow NPAFC and PICES scientists to add value to their respective science, provide synergies on regional and global issues, and enhance the visibility of both organizations. The first 25 years of PICES history shows that NPAFC found the most suitable and reliable partner to support the aspiration of salmon scientists in promoting their research. My hope is that NPAFC and PICES will continue to foster continued good relationships for the next 25 years and beyond.
25TH ANNIVERSARY CELEBRATION

NPAFC Celebrates 25 Years of Success

The NPAFC is celebrating its 25th Anniversary in 2017. To commemorate this important milestone, a special celebration is being held at the Victoria Conference Centre (VCC) Salon C, in Victoria, BC, on Monday, May 15, 2017, starting at 13:30.

This event is open to the public and will include presentations by dignitaries and individuals who have been instrumental to NPAFC progress over the last 25 years. In addition, there will be poster presentations, and musical performances. This landmark anniversary provides the NPAFC with an opportunity to reflect on its establishment, review its successes, and outline its contribution to fisheries enforcement and to the science of Pacific salmon and steelhead in the North Pacific Ocean.

Monday afternoon’s celebration will include a welcoming presentation, plenary presentations reviewing the last 25 years, posters, and other displays.

Individuals from organizations involved in activities related to Pacific salmon and steelhead, and/or fisheries enforcement are welcome to bring their posters to display during the event. If you wish to display a poster, the preferred maximum size of a poster is 36 inches wide x 48 inches high (91 cm wide x 122 cm high). Posters should be delivered to the NPAFC Secretariat office (VCC, Sidney Room, 2nd floor) no later than 12:00 (noon) on Monday, May 15, 2017. Individuals wishing to display a poster must contact the NPAFC Secretariat by April 15, 2017.

Please come to the NPAFC 25th Anniversary Celebration to enjoy meeting new and old friends, to reminisce, and to consider the future. We hope to see you there!

To display your poster and for any event questions, please contact secretariat@npafc.org or call 1-604-775-5550.
NPAFC Bulletin 6 Now Available for Download

1. Migration and Survival Mechanisms of Salmonids during Critical Periods in Their Marine Life History

- Size-selective mortality of Chinook salmon in relation to body energy after the first summer in nearshore marine habitats

- Thiamine and lipid utilization in fasting Chinook salmon

- An exploratory assessment of thiamine status in western Alaska Chinook salmon (Oncorhynchus tshawytscha)

- The influence of environmental variation on the Columbia River estuarine fish community: implications for predation on juvenile salmonids

- Initial estimates from an integrated study examining the residence period and migration timing of juvenile sockeye salmon from the Fraser River through coastal waters of British Columbia

- Early marine migration of juvenile chum salmon along the Pacific coast of eastern Hokkaido

- Adapting Hokkaido hatchery strategies to regional ocean conditions can improve chum salmon survival and reduce variability

- Effects of release timing on the recovery of late-run chum salmon in the Okhotsk Sea coast of Hokkaido, Japan

• Observations of steelhead in the California Current lead to a marine-based hypothesis for the “half-pounder” life history, with climate change implications for anadromy

• A water-recycling system for hatchery rearing of chum salmon fry
  T. Shimizu, T. Morita, and Y. Yamamoto

• Pacific salmon and steelhead: life in a changing winter ocean

• Is winter the critical period in the marine life history of Pacific salmon?
  S.V. Naydenko, O.S. Temnykh, and A.L. Figurkin

• Stock-specific abundance of chum salmon in the central Gulf of Alaska during winter
  S. Urawa, T.D. Beacham, S. Sato, T. Kaga, B.A. Agler, R. Josephson, and M. Fukuwaka

• Allometric relationships between body size and energy density of juvenile Chinook (Oncorhynchus tshawytscha) and chum (O. keta) salmon across a latitudinal gradient
  J.H. Moss, J.M. Murphy, E.A. Fergusson, and R.A. Heintz

• Chinook salmon first-year production indicators from ocean monitoring in Southeast Alaska

2. Climate Change Impacts on Salmonid Production and Their Marine Ecosystems

• Temporal and spatial variation in growth condition of Pacific salmon
  H. Ueno, M. Kaeriyama, M. Otani, M. Oe, Y. Qin, M.N. Aita, S. Yoon, and M.J. Kishi

• Correlations between winter sea surface temperatures in the North Pacific Ocean and continental-scale commercial catches of Pacific salmon, 1983–2013
  A.V. Bugaev, O.B. Tepnin, and K.W. Myers

• Variation in zooplankton and micro-nekton biomass in response to seawater temperature changes in the central Bering Sea during summer
  T. Sato, S. Sato, S. Urawa, and T. Nagasawa

• Distribution, diet, and bycatch of chum salmon in the eastern Bering Sea
  J.M. Murphy, E.V. Farley, Jr., J.N. Ianelli, and D.L. Stram

• Potential role of the magnetic field on homing in chum salmon (Oncorhynchus keta) tracked from the open sea to coastal Japan
  T. Azumaya, S. Sato, S. Urawa, and T. Nagasawa

3. Retrospective Analysis of Key Salmonid Populations as Indicators of Marine Ecosystem Conditions

• Future climate-related changes in fish species composition including chum salmon (Oncorhynchus keta) in northern Japanese waters, inferred from archaeological evidence
  Y. Ishida, A. Yamada, and K. Nagasawa
### 1. Changes in the trophic structure of an epipelagic community in the western Bering Sea and western North Pacific Ocean with an emphasis on Pacific salmon (Oncorhynchus spp.)

A.V. Zavolokin, V.I. Radchenko, and S.V. Naydenko

### 2. Recent decline of pink salmon (Oncorhynchus gorbuscha) abundance in Japan

T. Saito, Y. Hirabayashi, K. Suzuki, K. Watanabe, and H. Saito

### 3. Population dynamics of pink salmon in the Sakhalin-Kuril region, Russia

A.M. Kaev and J.R. Irvine

### 4. Changing growth and maturity in western Alaskan Chinook salmon, Oncorhynchus tshawytscha, brood years 1975–2005

M.V. McPhee, J.M. Leon, L.I. Wilson, J.E. Siegel, and B.A. Agler

### 5. Effects of climate and competition for offshore prey on growth, survival, and reproductive potential of coho salmon in Southeast Alaska

L.D. Shaul and H.J. Geiger

### 6. Pink and sockeye salmon interactions at sea and their influence on forecast error of Bristol Bay sockeye salmon

G.T. Ruggerone, B.A. Agler, B.M. Connors, E.V. Farley, Jr., J.R. Irvine, L.I. Wilson, and E.M. Yasumiishi

### 7. Stock-recruit analyses of Fraser River sockeye salmon


### 8. Habitat manipulations confound the interpretation of sockeye salmon recruitment patterns at Chilko Lake, British Columbia


#### 1. Genetic identification of juvenile pink salmon improves accuracy of forecasts of spawning runs in the Okhotsk Sea basin

N.Yu. Shpigalskaya, A.I. Kositsina, U.O. Muravskaya, and O.N. Saravansky


T.D. Beacham, J.R. Candy, S. Sato, and S. Urawa

#### 3. Occurrence of white-fleshed coho salmon in northern Southeast Alaska

W.R. Heard

#### 4. Genetic analysis identifies consistent proportions of seasonal life history types in Yukon River juvenile and adult chum salmon

C.M. Kondzela, J.A. Whittle, C.T. Marvin, J.M. Murphy, K.G. Howard, B.M. Borba, E.V. Farley, Jr., W.D. Templin, and J.R. Guyon

#### 5. Genetic variation in chum salmon in the Sanriku Region, Japan, inferred from mitochondrial DNA analysis

H. Tsukagoshi, S. Terui, G. Ogawa, S. Sato, and S. Abe
5. **Forecasting Salmonid Production and Linked Ecosystems in a Changing Climate**

- **Applying the Krogh Principle to find shortcuts to understanding Pacific salmon production**
  
  R.J. Beamish and C.M. Neville  

- **Feeding habits and trophic levels of Pacific salmon (Oncorhynchus spp.) in the North Pacific Ocean**
  
  Y. Qin and M. Kaeriyama  

- **Forecasting pink salmon production in Southeast Alaska using ecosystem indicators in times of climate change**
  
  J.A. Orsi, E.A. Fergusson, A.C. Wertheimer, E.V. Farley, Jr., and P.R. Mundy  


- **Forecasting Pacific salmon production in a changing climate: a review of the 2011–2015 NPAFC Science Plan**
  
NEW DEPUTY DIRECTOR

New NPAFC Deputy Director: Jeongseok Park

Jeongseok Park was selected as the new Deputy Director of the NPAFC and begins his appointment in Vancouver, BC, in February 2017.

In anticipation of his arrival at the Secretariat, Jeongseok said, "I have participated in lots of international meetings while giving priority to national interests over the last ten years. However, from now on, I will do my best to be a valuable asset in my personal capacity based on my career and experience in order to successfully operate within the Secretariat and the Commission in an effective, efficient, and cooperative manner. At the same time, I will make every effort to enhance NPAFC functioning so that it continues as an exemplary international organization dedicated to conserving fisheries resources, particularly Pacific salmon, and to fighting against IUU fishing in the North Pacific. To achieve our common goal, I will contribute to strengthening practical international cooperation in terms of enforcement, compliance, and scientific research, not only among our members, but also among other relevant international organizations, such as NPFC, PICES, and WCPFC." [NPFC, North Pacific Fisheries Commission, PICES, North Pacific Marine Science Organization, and WCPFC, Western and Central Pacific Fisheries Commission.]

Jeongseok was born and raised in Busan, Republic of Korea, and lived there for almost 30 years. After leaving Busan, he resided in Seoul for several years and then he and his wife, Bomi, moved to Sejong City, the new administrative capital in 2012. He received his Bsc, MSc, and has completed the coursework for a PhD in Fisheries Resources Economics at Pukyong National University in Busan. His areas of special interest include bio-economics of fisheries management; quota allocation arrangements; and fisheries monitoring, control, and surveillance; including catch document systems, port states measures, and high seas boarding inspection.

Jeongseok worked for the Korea Maritime Institute as a fisheries researcher, where he studied Korean domestic fisheries issues, including socio-economic assessments and evaluations. In 2006 he joined the International Cooperation Division (now Distant Water Fisheries Division) of the Ministry of Oceans and Fisheries. Since then, he has represented the Korean government as a Fisheries Negotiator at international fisheries organizations, including the International Commission for the Conservation of Atlantic Tunas (ICCAT), Indian Ocean Tuna Commission (IOTC), North Pacific Fisheries Commission (NPFC), International Whaling Commission (IWC), and other regional fisheries management organizations. Jeongseok has served as the Vice-Chairperson of the IOTC since May 2013 and as the Vice-Chairperson of the Technical and Compliance Committee of the NPFC since August 2016. In December 2016 Jeongseok was promoted to Senior Fisheries Officer in his Ministry in recognition of his chairmanship and dedication to international fisheries organizations.

At NPAFC, Jeongseok was appointed a Representative of Korea in 2010. From 2011 to 2014, he served as Chairperson of the Committee on Enforcement, and from 2014 to 2016 he was the Chairperson of the Committee on Finance and Administration. In May 2016 Jeongseok was elected Vice President of NPAFC. When Jeongseok joins the Secretariat as Deputy Director, he will step down from his posts at the IOTC, NPFC, and his other positions at NPAFC.

Jeongseok enjoyed and appreciates the life-enhancing experiences that have come from his opportunities to visit the diverse cultures of Western, European, African, and Arab peoples in the Pacific, Atlantic, and Indian Oceans as a result of his fisheries management career. He now looks forward to the new experience of working at the Secretariat and the opportunity to bring his family to live in the beautiful city of Vancouver, BC.
NPAFC Newsletter Editorial Responsibilities Pass to New Editor

By Nancy Davis
Newsletter Editor

As outgoing Deputy Director at NPAFC, this is my final issue of the NPAFC Newsletter as Editor. During my six years, I have enjoyed immensely soliciting articles and assisting authors and the NPAFC Secretariat staff in publishing each issue. It has been my pleasure to support disseminating scientific, fisheries enforcement, and Commission-related information to the public. The next Editor and incoming NPAFC Deputy Director, Jeongseok Park, will take-up his responsibilities as Editor in organizing and publishing the upcoming (summer) issue.

The subject areas and photos published in the newsletter have varied widely but the common theme is that the material relates to NPAFC news, such as Pacific salmon and steelhead biology and fishery management, ocean fisheries enforcement, and international fisheries governance. The newsletter also regularly includes a reader’s favorite salmon recipe. The spectrum of newsletter content has varied with the hopes that each reader will find at least one article of interest in each issue.

Our newsletter readers are widely dispersed around the North Pacific Rim and include people in regional and national fisheries management, enforcement agencies, universities, non-profit organizations, international inter-governmental organizations, and interested individuals. Despite these varied backgrounds, our readers are interested in issues related to conservation of Pacific salmon and steelhead in the North Pacific Ocean.

For those of you who have not written an article for the newsletter, I urge you to consider sending article ideas to Jeongseok Park. For those of you who are regular contributors, I thank you, and urge you to consider submitting new material.

Thank you to everyone for your consideration during my term as Editor. I have thoroughly enjoyed working with authors and NPAFC Staff on production and distribution of the newsletter.

And best wishes to Jeongseok Park, who can be reached at jpark@npafc.org starting February 1, 2017.
INTERNSHIP PROGRAM

Accepting Applications for 2017 NPAFC Internship Program

APPLICATION DEADLINE: March 16, 2017

The North Pacific Anadromous Fish Commission (NPAFC) invites citizens from its member countries (Canada, Japan, Republic of Korea, Russian Federation, and USA) to apply for the NPAFC Internship Program. One intern will be accepted upon approval of the Commission. The intern will work at the NPAFC Secretariat office in Vancouver, BC, Canada.

The intern will gain experience and knowledge in operations of the NPAFC and will have the opportunity to test their interest in international governmental organizations, management, fisheries, biology, ecology, and fisheries enforcement. The intern will work under the supervision of the Executive Director and/or his designate. In general, the intern will assist in a variety of tasks, including

• plan, develop, and complete an individual project in communication, scientific, or administrative areas,
• prepare information for and provide support to special projects,
• assist organizing and editing various NPAFC publications,
• coordinate international cooperative programs and assist Secretariat activities

Internship period: Starts on or about September 1, 2017, for a period up to a maximum of 6 months. The intern is expected to perform their tasks at the Secretariat office on a daily basis, Monday-Friday, 7.5 hours per day.

Qualifications: Applicants must be a citizen of a NPAFC member country, have a university degree, the ability to read, write, and speak English, the ability to use computers and the internet; and demonstrated personal initiative. Applicants must currently be a part of the government or academic sector, a recent graduate, or currently enrolled in school for an advanced degree.

Financial support: NPAFC will provide a stipend of $2,500 CDN per month. Travel cost to and from the intern’s place of residence and the location of the Secretariat office and cost of medical insurance will be at the intern’s own expense or by home country support. Travel expenses associated with the intern’s work in the Secretariat will be covered by NPAFC.

Applications: Completed applications must include all of the following:

• cover letter describing the applicant’s interests and qualifications,
• resume showing academic and/or work experience,
• three professional letters of reference,
• Personal Data Page of passport as a citizenship proof.

Email the completed application to secretariat@npafc.org by March 16, 2017.

For complete information: Go to www.npafc.org/new/about_internship.html and contact the NPAFC Secretariat for questions at secretariat@npafc.org.

Like our page on Facebook to stay updated with NPAFC events, publications, internship opportunities, delicious salmon recipes, and much more:

Find us on Facebook
Smoked salmon cream cheese pasta is a true Canadian-style West Coast comfort food and an all-time favourite of my friends and family—and it is requested at every get-together! It’s quick and easy to make and a perfect one-pot meal for serving at larger gatherings. Either cold or hot smoked salmon will do for this recipe, but I prefer hot smoked, which is pictured here, as its firmer texture combines well with pasta and provides a stronger “smoky” flavour, as compared to the more subtle flavour and softer texture of cold smoked salmon. Chum salmon is shown here, and any species of Pacific salmon can be used, but my favourites are the rich and buttery flavor of Chinook and sockeye salmon. This recipe serves for 4–5 people.

Smoked Salmon Cream Cheese Pasta
By Madeline Young
2016 NPAFC Intern

Ingredients

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 package (~ 450 g)</td>
<td>spaghetti (or other pasta) and reserved pasta water</td>
</tr>
<tr>
<td>1 medium</td>
<td>red onion thinly sliced</td>
</tr>
<tr>
<td>300 g</td>
<td>smoked salmon torn or chopped into small pieces</td>
</tr>
<tr>
<td>250 g</td>
<td>cream cheese cut into approximately 2-cm pieces and left out of the refrigerator to soften</td>
</tr>
<tr>
<td>1 bunch</td>
<td>fresh dill removed from the stalk and finely chopped</td>
</tr>
<tr>
<td>3 tablespoons</td>
<td>pickled capers</td>
</tr>
<tr>
<td>Salt and pepper</td>
<td>to taste</td>
</tr>
</tbody>
</table>
Instructions

1. Bring a large pot of salted water to boil and add the pasta.
2. Cook pasta al dente (cooked, but firm to the bite). Reserve ~1 cup of the pasta water.

3. Add sliced red onion to the pot of boiling water approximately 10 seconds prior to straining pasta, then strain.

4. Return pasta to the pot. Add smoked salmon, cream cheese, dill, and capers.

5. Add ~¼ cup of the reserved pasta water to the pot and stir to combine ingredients. If needed, continue to add small amounts of the pasta water until a creamy consistency is attained (you will not require all of the reserved pasta water).

6. Add salt and pepper to taste and serve immediately.
NPAFC Bulletin 6


NPAFC Technical Report 10

includes a narrative and thorough description of the initial proposal and planning process for the International Year of the Salmon (IYS).

IYS North Pacific Steering Committee Meeting

Dates: February 28–March 1, 2017 Full Group Meeting
March 2, 2017 Working Group Meeting
Venue: Vancouver Airport Marriott Hotel
Richmond, BC, Canada
www.vancouverairportmarriott.com

Committee on Enforcement Joint Patrol Schedule Meeting

Dates: February 14–16, 2017
Venue: Email Meeting

25th Anniversary Celebration

Dates: May 15, 2017
Venue: Victoria Conference Centre
Victoria, BC, Canada
More information will be available at www.npafc.org

NPAFC 25th Annual Meeting

Dates: May 15–19, 2017
Venue: Victoria Conference Centre
Victoria, BC, Canada
www.npafc.org/new/events.html

Visit the NPAFC website: www.npafc.org for more information on events, publications, scientific documents, and salmon catch statistics.

The Commission encourages submission of ideas, articles, and images on NPAFC-related activities for publication in the newsletter.

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