NPAFC
Doc. 1472
Rev. ___

Canadian Juvenile Salmon Surveys in 2013-2014

by

Marc Trudel, Chrys Neville, and Ruston Sweeting

Fisheries and Oceans Canada
Science Branch, Pacific Region
Pacific Biological Station
3190 Hammond Bay Road
Nanaimo, BC, Canada
V9T 6N7

Submitted to the
NORTH PACIFIC ANADROMOUS FISH COMMISSION

by

CANADA

APRIL 2013

THIS PAPER MAY BE CITED IN THE FOLLOWING MANNER:
Trudel, M., C. Neville, and R. Sweeting. 2013. Canadian Juvenile Salmon Surveys in 2013-2014. NPAFC Doc. 1472. 9 pp. (Available at http://www.npafc.org).

1.0. INTRODUCTION

Pacific salmon have a complex life cycle that involves a freshwater phase for spawning and rearing, as well as an ocean phase where they spend the greater part of their lives and gain the bulk of their mass and energy necessary for successfully completing their spawning migration (Groot and Margolis 1991). Pacific salmon experience heavy and highly variable losses in the ocean, with natural mortality rates generally exceeding 90-95% during their marine life (Bradford 1995). Most of this mortality is thought to occur during two critical periods: an early predation-based mortality that occurs within the first few weeks to months following ocean entry and a starvation-based mortality that occurs following their first winter at sea (Beamish and Mankhen 2001). Hence, Canada currently maintains two research programs on the marine biology of Pacific salmon to understand the processes regulating Pacific salmon production in the marine environment, the interactions between wild and hatchery-reared salmon, the potential interactions between wild/hatchery salmon and aquaculture production, the impacts of ocean conditions and climate change on marine ecosystems and salmon resources, and to provide a sound scientific basis for optimizing hatchery production. Thus, an offshore program conducts research off the west coast of British Columbia and Southeast Alaska, and an inshore program works in the Strait of Georgia and Puget Sound. In this document, we present the juvenile salmon research surveys that have been planned in Offshore and Inshore areas by Canada for 2013-2014.

2.0. JUVENILE SALMON RESEARCH SURVEYS

2.1. GENERAL SURVEY INFORMATION

Three integrated epipelagic mid-water trawl surveys have been planned for the *CCGS W.E. Ricker* in 2013-14: an early summer (June 25-July 22, 2013), a fall survey (September 17-November 10, 2013), and a winter survey (March 6-21, 2014). These surveys will focus on water bodies surrounding Vancouver Island including the Strait of Georgia, Gulf Islands, Juan the Fuca Strait, Johnstone Strait, Queen Charlotte Strait, Queen Charlotte Sound, the west coast of Vancouver Island, and Puget Sound (Table 1-3; Figure 1-2). Traffic in both Puget Sound and Juan de Fuca limits these surveys to relatively near shore areas. The primary objectives of these surveys will be to (1) collect biological information on Pacific salmon (*Oncorhynchus* spp.) and associated epipelagic fish community, (2) collect DNA samples for stock identification purposes, (3) describe the ambient oceanographic conditions, and (4) quantify the biomass of zooplankton and describe zooplankton species community composition in coastal waters of British Columbia.

A mid-water trawl survey has also been planned for June 1-10, 2013. For this survey, scientific operations will be conducted in the Strait of Georgia using the same sampling equipment as for the *CCGS W.E. Ricker* surveys. The primary focus of this survey is to determine the distribution, abundance and health of juvenile Fraser River sockeye salmon during their early marine life and peak abundance in this inland sea (Table 4; Figure 1). The dates for this survey are currently tentative, as this survey will be conducted using a fishing vessel that will be chartered later this year. As a consequence, the number of berths available for this survey is currently unknown.

Two mid-water trawl surveys have also been planned for the *CCGS Neocaligus*: a spring survey (April 30-May 8, 2013) and a summer survey (June 22-28, 2013). This smaller

vessel has recently been re-fitted to conduct mid-water trawls. The trawl net is a smaller version of the net fished from the CCGS W.E. Ricker. The primary objectives of these surveys will be to test the trawl gear that have been designed for this vessel to ensure adequate fishing speed and net opening can be achieved with this smaller vessel. In addition, some trawl sets will be conducted alongside the *CCGS W.E. Ricker* in late June to provide comparison in catch rates of the the two nets and vessels. The NeoCaligus surveys will be conducted in the Strait of Georgia and the Gulf Islands (Table 5-6)

Additional scientists are encouraged to participate on any of these surveys, pending security clearance, which generally requires several months advance effort, and the number of berths available.

2.2. FISHING GEAR AND FISHING OPERATION

The *CCGS W.E. Ricker* and chartered vessel will fish a mid-water trawl at 4.5 – 5 knts for 30 minutes at either the surface, 15m, 30m, and 2.5-3.0 knts at 45m or 60m. Occasional deeper sets may be conducted. The length of tow may be reduced to 10-15 min in some areas (Gulf Islands, Quatsino Sound, Puget Sound), dependent on densities and/or catch limits established for these areas. The trawl net is designed by Cantrawl Nets Ltd, Richmond, BC. It has has a heavy-duty front end of hexagonal web made from 3/8 in. (9.5 mm) and 5/16 in. (7.9 mm) Tenex rope, and a tapered body made-up of 64 in. (163 cm), 32 in. (81.3 cm), 16 in. (40.6 cm), 8 in. (20.3 cm) and 4 in. (10.2 cm) polypropylene sections, an intermediate section of 3 in. (7.6 cm) polypropylene, and a codend of 1.5 in. (3.8 cm) knotted nylon lined with 0.25 in. mesh (64 mm). The trawl has three 40 m bridles of 5/8 in. (1.6 cm) wire rope per side that are attached with a single hook-up to 5 m Jet doors. Typically, 100-150 m of 1.25 in. (3.2 cm) warp is paid out to tow the trawl at the surface. In good sea conditions, this configuration typically achieves a mouth opening that is approximately 30 m wide by 15 m deep as measured acoustically by a Scanmar trawl eye mounted on the headrope. Additional warp is used for fishing at greater depths. The majority of the catch of Pacific salmon is in the surface sets (Beamish et al. 2007), however, significant numbers (and CPUE) are seen at deeper depths and there are strong species-specific and seasonal trends (Trudel and Tucker 2013). In the summer surveys, fishing begins at 0600 and continues until 1800. In the fall, due to the later sunrise timing, fishing begins at 0700 and continues until 1900 or until darkness (October/November). Vessel details for the *CCGS W.E. Ricker* can be found at: http://www.ccg-gcc.gc.ca/Fleet/Vessel?vessel_id=116.

For the *CCGS Neocaligus*, Cantrawl Nets Ltd, Richmond developed a net using the same design as the net used on the W.E. Ricker. The modified net is smaller in opening and is built using lighter web and 3/4 in. (),150 ft () Spectra bridles. The focus was to create a net that could be fished at the surface at 4.5 – 5knts using the smaller vessel. Thyburon trawl doors are used on this vessel. Testing of gear in 2013 will determine if the modfications made to net are sufficient to achieve targeted fishing speeds and mouth opening or if additional modification are required. Vessel details for the *CCGS Neocaligus* can be found at: http://www.ccg-gcc.gc.ca/Fleet/Vessel?vessel_id=86.

The fish samples are sorted by species, enumerated, and measured onboard the ship to characterize the nekton community in epipelagic waters of British Columbia and Puget

Sound (Brodeur et al. 2006; Orsi et al. 2007). If the catches are too large to measure all the fish, then random subsamples of 60-200 fish are measured. Counts (or volumetric estimates of large catches, N > 500) are then made for the rest of the catch. All the juvenile coho and Chinook salmon are systematically scanned for coded-wire tags, irrespective if their adipose fin has been clipped or not, as not all the tagged fish are clipped (Morris et al. 2004). In Puget Sound, CWTs are retained and decoded by WDFW personnel. Clips of pelvic and pectoral fins, while not as prevalent as in years past, are also recorded. For juvenile salmon, a skin sample is from the operculum using a hole-punch or a caudal fin clip is taken and these tissues are preserved in 95% ethanol to determine their stock of origin using microsatellite DNA (Beacham et al. 2001, 2005, 2006). In addition,calcified-structures (i.e. scales and otoliths) are sampled for age determination. For gene expression studies in Pacific salmon, in conjunction with K. Miller-Saunders at PBS, a subsample of 5-10 salmon are taken immediately upon retrieval of the catch, with emphasis on the liveliest fish and tissue samples (muscle, brain, liver etc) are immediately frozen in liquid nitrogen, dry ice or -80ºC Ultra cold freezer or preserved in RNA-later.

Stomach contents (from cardiac to pyloric constrictions) of juvenile salmon are removed for dietary analyses either directly on board the ship or in the laboratory (Brodeur et al. 2007; Sweeting and Beamish 2009). Estimates of % fullness, total volume and degree of overall digestion are recorded. Finally, the entire stomach contents are broken down into percent contribution by individual prey groups. Dependent on particular items, the level of prey identification is at least to family, but often to the genus level (eg., Sweeting and Beamish 2009, Duffy et al. 2010). When time permits, stomach of certain bycatch species are also examined (eg., hake, dogfish, Pollock, herring). The diet analyst has been the same trained, qualified person for all of the surveys and is the same individual that performs diet analysis in the laboratory at the Pacific Biological Station (PBS). A subsample of the catch is preserved frozen individually at –20ºC or -80ºC for various chemical and calorimetric analyses such as stable isotopes, for additional DNA samples if required and for laboratory examination of stomach contents.

Biological data collected for each salmon include species common name, fork length (mm) and/or total length (mm), and observed fin clip. It will also include, when available, whole body weight (g wet), sex, stomach content weight (g wet), % water that is based on the ratio of dry to wet whole body weight, coded wire tag number, and pit tag number. Age separation is generally determined based on examination of fork length distributions, that showed non-overlapping size modes for chum, coho, pink, and sockeye salmon (Trudel et al. 2007a). For Chinook salmon, we used a combination of coded-wire tag recoveries of known-age fish and DNA analyses to establish size-classes to separate juveniles from adults, and life history types (Fisher et al. 2007; Trudel et al. 2007b), as there is considerable overlap among size modes that represent the multiple age groups.

2.3. OCEANOGRAPHIC SAMPLING

At oceanographic stations, the scientific crew will conduct CTD (conductivity-temperature-depth) casts. On some surveys oceanographic sampling will also (1) collect seawater samples at 10 m from the surface with a Niskin bottle for nitrate, phosphate, silicate, and salinity, and (2) filter surface seawater on GF/F glass fibre filter disks for chlorophyll a. Nitrate, phosphate, and silicate samples will be collected in acid-washed glass test tubes, whereas the glass fiber disks will be folded and placed in

polypropylene scintillation vials. All these samples will be stored frozen. CTD casts will be conducted to 250 m or within 5 m of the bottom with a Seabird SBE 911+ probe. Several calibration samples from selected CTD casts will be collected over the course of the survey with Niskin bottles at depths where the salinities are stable. The oceanographic data collected in these surveys will be stored on a database maintained at the Institute of Ocean Sciences (Sidney, British Columbia).

2.4. ZOOPLANKTON SAMPLING

Vertical bongo tows to approximately 150 m or within 10 m of the bottom will be conducted with two 57 cm diameter, 253 μm Nitex nets. One of the nets is equipped with a flowmeter. Zooplankton collected from the flowmeter side will be preserved in 10% formalin and sent to the zooplankton laboratory at the Institute of Ocean Sciences, Fisheries and Oceans Canada (Sidney, BC) for species classification and enumeration. Zooplankton taken from the net without flowmeter will be sorted into four size fractions by successively sieving through 8.0, 1.7, 1.0, and 0.25 mm screens. Each size fraction will then be weighed wet, dried at 60ºC for 48 hours, re-weighed, and stored in plastic bags for future stable isotope, bomb calorimetry, and proximate analyses. The zooplankton data collected in these surveys will be stored on a database maintained at the Institute of Ocean Sciences (Sidney, British Columbia).

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Table 1. Tentative summer survey itinerary for the *CCGS WE Ricker* (June 25 – July 22, 2013).

Date	General area of operations
June 25	PBS Nanaimo, loading
June 26-July 8	Strait of Georgia, eastern Discovery Islands, Gulf Islands
July 9-12	Puget Sound and Juan de Fuca Strait,
July 13-17	West Coast of Vancouver Island
July 18-21	Queen Charlotte Sound , Queen Charlotte Strait, and Jonstone Strait
July 22	PBS Nanaimo, off loading

Table 2. Tentative fall survey itinerary for the *CCGS WE Ricker* (September 17 – November 10, 2013).

Date	General area of operations
September 17	PBS Nanaimo, loading
September 18-October 2	Strait of Georgia, eastern Discovery Islands, Gulf Islands
October 3-6	Puget Sound and Juan de Fuca Strait
October 7-12	Johnstone Strait, Queen Charlotte Strait
October 13-14	Port McNeil – Crew Change & Maintenance
October 15-26	Queen Charlotte Sound, West Coast Vancouver Island
October 27	Victoria
November 2-8	Juan de Fuca Strait, Strait of Georgia
November 9-10	PBS Nanaimo, unloading

Table 3. Tentative winter survey itinerary the *CCGS WE Ricker* (March 6-21, 2014).

Date	General area of operations
March 6	PBS Nanaimo, loading
March 7-12	Strait of Georgia
March 13-20	West coast of Vancouver Island
March 21	PBS Nanaimo, off loading

Table 4. Tentative spring survey itinerary for the chartered vessel (June 1-10, 2013).

Date	General area of operations
June 1	PBS Nanaimo, loading
June 2-10	Strait of Georgia, Discovery Islands (East)
June 10	PBS Nanaimo, off loading

Table 5. Tentative spring itinerary for the *CCGS Neocaligus* (April 30 – May 8, 2013)

Date	General area of operations
April 30	PBS Nanaimo, loading
May 1-2	Electronics testing
May 3-7	Gulf Islands
May 8	Off loading, Nanaimo

Table 6. Tentative summer itinerary for the *CCGS Neocaligus* (June 22-28, 2013)

Date	General area of operations
June 22	PBS Nanaimo, loading
June 23-25	Strait of Georgia (fishing and oceanography)
June 26-27	Comparative fishing in SOG with WE Ricker
June 28	Off loading, Nanaimo

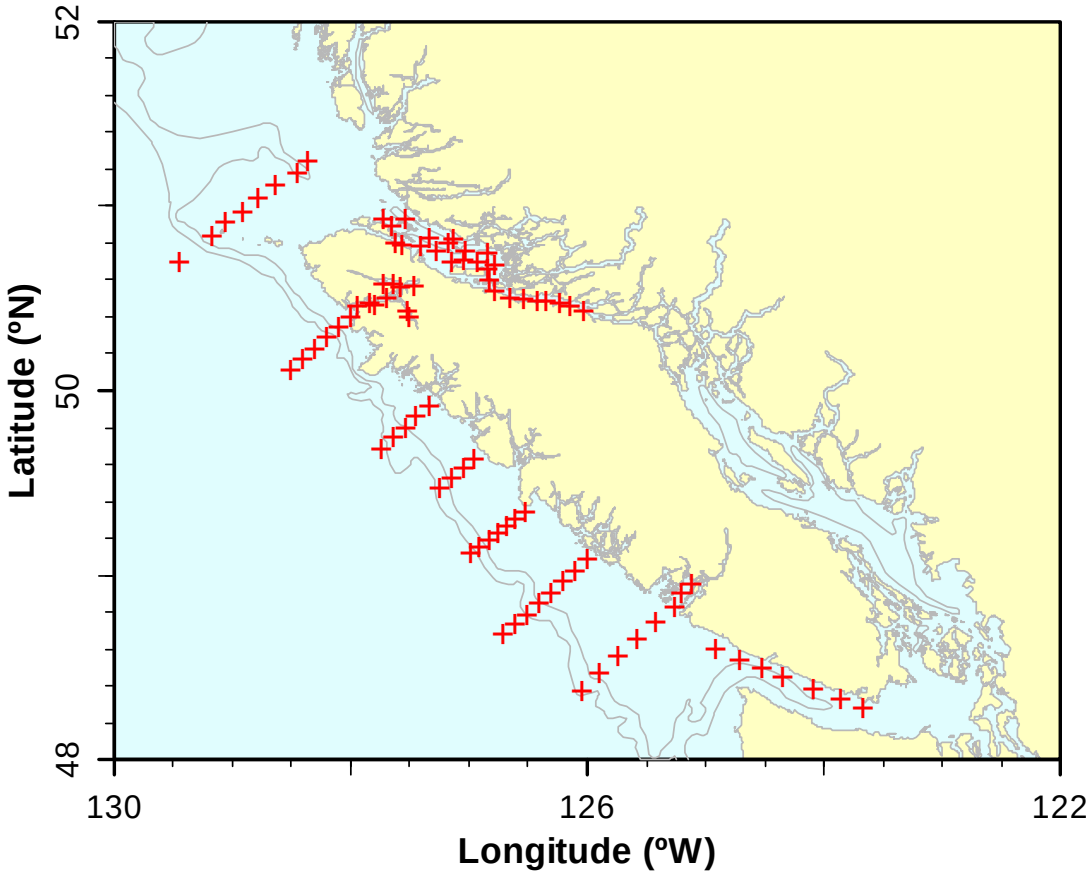

Figure 1. Tentative survey stations for the *CCGS WE Ricker* on the west coast of Vancouver Island, Queen Charlotte Sound and Queen Charlotte Strait.

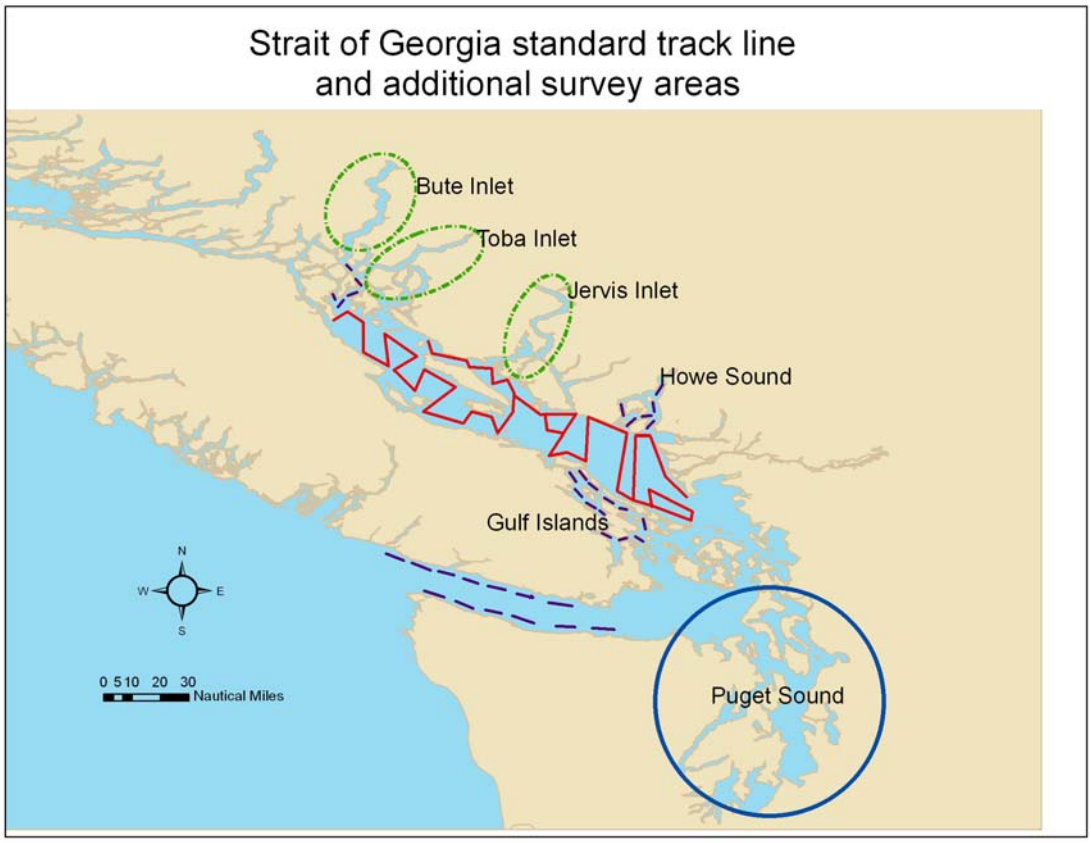

Figure 2. Generalized map of Strait of Georgia, British Columbia. Track lines for the July and September surveys are shown in red. The Gulf Islands region is in the south-west portion of the strait, bounded by Vancouver Island on the western side. Boundary Bay extends south from Point Roberts along the eastern shoreline. Puget Sound set locations are not shown in this map but region is circled. Juan de Fuca strait tracklines are essentially along either shoreline, as the middle areas are traffic lanes. Eastern Discovery Islands included the purple dashed lines at northern end of Strait of Georgia and lower portions of Bute and Toba Inlet.