Rachel Carson Scientific Excellence Award (Group)

Blair Flannery, Ora Schlei and Cara Lewis - Conservation Genetics Laboratory Mixed-Stock Analysis Rapid Response Team - is hereby nominated by Geoff Haskett, Regional Director, Region 7

Scientific Contribution

The Service has a unique, federally mandated role to manage the subsistence chum salmon fishery in the Yukon River, which flows more than 2000 miles through Canada and Alaska. Chum salmon spawn throughout the drainage in both countries and, similar to all salmon, they are known to exhibit fidelity to natal spawning grounds. Along the entire length of the Yukon River, chum salmon are an extremely important resource for subsistence and commercial fisheries in both the U.S. and Canada. Yukon River chum salmon are managed under the Pacific Salmon Treaty, which mandates conservation and equitable sharing of the resource between the two countries. Determining the relative contributions and origin of stocks caught in the harvest is essential for effective conservation and management in accordance with the international treaty.

The management of the Yukon River chum salmon fishery is difficult and contentious because of return strength uncertainty and the diverse needs of many user groups in Alaska and northwestern Canada. Most Yukon River chum salmon are harvested from mixtures of stocks, hundreds or thousands of miles from their spawning grounds, which further complicates conservation and management. Determining relative stock contributions of chum as they enter the river would assist managers in meeting Pacific Salmon Treaty obligations by giving them the ability to modify day-to-day harvest regulations during the season. Furthermore, successful conservation can only be realized by harvesting stocks at sustainable rates to avoid the negative side effects of decreased production and diminished biodiversity that result from excessive exploitation.

Federal fishery managers from the Service work cooperatively with the State of Alaska and the Canadian Department of Fisheries and Oceans to regulate harvest among commercial and subsistence fisheries in the U.S. and Canada. There are several objectives in the management of this complex fishery, primary among them are ensuring enough chum reach the spawning grounds in both countries, pursuant to the international Pacific Salmon Treaty, and that subsistence needs are met by Yukon River communities in both countries. Attempts to identify discrete stocks of Yukon River chum salmon began with tagging studies in 1976, but the resolution has been insufficient for management needs…until now.

To achieve their management objectives, fishery managers from the U.S. and Canada now rely heavily on the in-season genetic information provided by the Alaska Region Conservation Genetics Laboratory Mixed-Stock Analysis Rapid Response Team (Team): Blair Flannery (lead), Ora Schlei and Cara Lewis. The Team has developed genetic methods that provide a new type of real-time genetic information for application to a federally managed fishery. The Team's method represents the development of completely new data and information type that provides unique insights into a fish conservation issue of extreme importance and international visibility.

Scientific Application

Genetic mixed-stock analysis is used by the Team to estimate the relative proportion of specific Yukon River chum salmon stocks as they enter the river and as they are harvested. The Team has successfully applied this analysis to assist in the management of Yukon River chum salmon since 2004. This analysis is only possible due to the large genetic baseline of chum populations, collected and assembled over the past 15 years by the Conservation Genetics Laboratory. Non-lethal tissue samples have been collected from over 5000 spawning fish representing 29 stocks from throughout this massive and remote drainage. Genetic relationships among populations have been determined through analysis of allelic variation at 22 microsatellite loci. Bayesian mixture modeling tests with samples of known origin were conducted to evaluate the power of the genetic baseline to apportion mixtures to reporting groups

defined by the genetic, geographic, and political relationships among the stocks and confirm that the baseline accurately apportions mixture samples to stock of origin.

Blair Flannery has led this project for from its inception. In fact, his Master's Thesis formed the foundation of this work. From June through September for each of the past seven summers, the entire Team has used genetic mixed-stock analysis methods to deliver weekly stock composition estimates to fishery managers. To achieve the rapid turn-around, the Team developed a special logistical protocol to get samples 375 air miles from the river to the laboratory using a combination of dedicated Refuge aircraft flights, couriers and air-freight services. Once the samples are in the laboratory, the Team uses a cadre of rapid analysis methods they have developed to genetically analyze the samples and compute the stock composition estimates, within about 24 hours.

This rapid turn-around from the river to the lab to the manager is a significant achievement and provides a unique form of information that is provided to the managers in real-time, helping them to modify subsistence and commercial fisheries on a weekly basis. The estimates provided by the Team provide a detailed allocation of the run to specific up-river stocks – all completed within about three days of the fish being sampled near the mouth of the Yukon River. No other source of information can provide these detailed analyses while the run is occurring and management practices can still be modified. The allocation reports are distributed to Service, State of Alaska and Canadian managers each week allowing them to adjust harvest regulations accordingly. This is the last step in the application of their unique and highly effective method that leads directly to extraordinary results in our ability to conserve chum salmon populations throughout the Yukon River.

Extraordinary Results

The key to managing the exploitation of co-mingling populations (a mixed stock) is timely, accurate and precise estimates of the composition of each population (stock) in the admixture. This information has allowed managers to use time and area harvest

restrictions to direct harvest away from under-abundant chum salmon stocks while focusing effort on stocks with a surplus breeding population. Acquiring this information is extremely important in this case where the harvest occurs weeks to months and 100's to 1000's of miles from when and where breeding occurs; management action cannot correct for overexploitation during the season with traditional monitoring methods. However, the unique genetic information now provided to federal and state managers on a real-time basis provide managers the ability to more effectively regulate fisheries in order to meet escapement goals, prevent differential harvest rates, and conserve genetic diversity - all of which are essential for sustained salmon productivity. The data provided by the Team to the state and federal fishery managers help them manage at a finer level than was previously possible. With stock composition and abundance data, managers are better equipped to protect weak stocks, meet escapement goals, fulfill treaty obligations, and maintain genetic diversity. Thanks to the rapid response capability developed by the Team, managers get the data they need on a weekly basis throughout the season.

This work was originated by the Service, but has been heavily collaborative. The Team developed a close collaboration with Canada and the State of Alaska to make the application of this work a success. The Team's work provides a fine example of working through truly difficult biological and political issues to provide extraordinary results in fish conservation. In fact, during the first several years of the project, the State of Alaska actually discouraged us from continuing this work. Through the dedication to the science and a persistent collaborative spirit exhibited by the team, the State of Alaska now not only uses the information, they have asked us to expand our analyses over the past few years and have helped us secure external funding to do so. The team provides an excellent example of the benefits of fostering a truly collaborative project with the State of Alaska and Canada for this highly contentious arena of subsistence and commercial fishery management.

The following peer-reviewed journal articles and agency reports have been produced in the last five years from this project:

Flannery BG, Beacham TD, Candy JR, Holder RR, Maschmann GF, Kretschmer EJ, Wenburg JK (2010) Mixed-Stock Analysis of Yukon River chum salmon: application and validation in a complex fishery. *North American Journal of Fisheries Management* 30, 1324-1338.

Flannery BG, Wenburg JK, Gharrett AJ (2007) Evolution of mitochondrial DNA variation within and among Yukon River chum salmon populations. *Transactions of the American Fisheries Society* 136:902-910.

Flannery BG, Wenburg JK, Gharrett AJ (2007) Variation of amplified fragment length polymorphisms in Yukon River chum salmon: population structure and application to mixed-stock analysis. *Transactions of the American Fisheries Society* 136:911-925.

Flannery BG, Holder RR, Maschmann GF, Kretschmer EJ, Wenburg JK (2010) Application of mixed-stock analysis for Yukon River fall chum salmon, 2008. Annual Report for Study 06-205, Fisheries Resource Monitoring Program, Office of Subsistence Management, U.S. Fish and Wildlife Service, Anchorage, Alaska.

Flannery BG, Wenburg JK, Evenson DE (2010) Yukon River summer chum salmon mixed-stock analysis, 2009. Final Report for Project RM-14-09, Yukon River Panel Research and Management Fund, U.S. Fish and Wildlife Service, Fairbanks, Alaska.

Flannery BG, Holder RR, Maschmann GF, Kretschmer EJ, Wenburg JK (2009) Application of mixed-stock analysis for Yukon River fall chum salmon, 2007. Annual Report for Study 06-205, Fisheries Resource Monitoring Program, Office of Subsistence Management, U.S. Fish and Wildlife Service, Anchorage, Alaska.

Flannery BG, Wenburg JK, Evenson DE (2009) Yukon River summer chum salmon mixed-stock analysis, 2008. Final Report for Project RM-14-08, Yukon River Panel Research and Management Fund, U.S. Fish and Wildlife Service, Fairbanks, Alaska.

Flannery BG, Holder RR, Maschmann GF, Kretschmer EJ, and Wenburg JK (2008) Application of mixed-stock analysis for Yukon River fall chum salmon, 2006. Alaska Fisheries Data Series Number 2008-5, U.S. Fish and Wildlife Service, Anchorage.

Flannery BG, Beacham TD, Holder RR, Kretschmer EJ, and Wenburg JK (2007) Stock structure and mixed-stock analysis of Yukon River chum salmon. Alaska Fisheries Technical Report Number 97, U.S. Fish and Wildlife Service, Anchorage.

500 word citation

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