SUMMARY REPORT OF LITERATURE REVIEW AND SYNTHESIS OF BIOLOGICAL GOALS FOR SALMONID AND OTHER SPECIES RECOVERY

PREPARED FOR:

State Water Resources Control Board
P.O. Box 100
Sacramento, CA 95812-0100
Contact: Matthew Holland
916.341.5947

PREPARED BY:

ICF
630 K Street, Suite 400
Sacramento, CA 95814
Contact: Ellen Unsworth
916.231.9619

October 2018
## Contents

List of Tables ............................................................................................................................................ i  
List of Acronyms and Abbreviations ....................................................................................................... ii

Introduction ............................................................................................................................................ 1  
  Purpose ............................................................................................................................................ 1

Methods ................................................................................................................................................. 1  
  Research ........................................................................................................................................... 1  
  Documentation ................................................................................................................................ 2  
  Final Sorting ..................................................................................................................................... 2

Results .................................................................................................................................................... 3  
  Primary Resource Documents ......................................................................................................... 3  
  Secondary Resource Documents ................................................................................................... 15  
  Other Potentially Useful Documents ............................................................................................. 16  
  Native Fish Monitoring in the Bay-Delta ........................................................................................ 16  
References Cited................................................................................................................................... 21

## Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Program Element Descriptions for the IEP Fish Monitoring Program</td>
<td>18</td>
</tr>
</tbody>
</table>
### Acronyms and Abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advisory Panel</td>
<td>panel</td>
</tr>
<tr>
<td>Bay</td>
<td>Chesapeake Bay</td>
</tr>
<tr>
<td>B-IBI</td>
<td>benthic index of biotic integrity</td>
</tr>
<tr>
<td>CDFW</td>
<td>California Department of Fish and Wildlife</td>
</tr>
<tr>
<td>Council</td>
<td>The Northwest Power Council</td>
</tr>
<tr>
<td>DFG</td>
<td>California Department of Fish and Game</td>
</tr>
<tr>
<td>DWR</td>
<td>California Department of Water Resources</td>
</tr>
<tr>
<td>EPA</td>
<td>U.S. Environmental Protection Agency</td>
</tr>
<tr>
<td>ESRP</td>
<td>Estuary and Salmon Restoration Program</td>
</tr>
<tr>
<td>HAB</td>
<td>Harmful Algal Blooms</td>
</tr>
<tr>
<td>HLI</td>
<td>high-level indicators</td>
</tr>
<tr>
<td>LIOs</td>
<td>Local Integrating Organizations</td>
</tr>
<tr>
<td>PSNERP</td>
<td>Puget Sound Nearshore Ecosystem Restoration Project</td>
</tr>
<tr>
<td>PSRITT</td>
<td>Puget Sound Recovery Implementation Technical Team</td>
</tr>
<tr>
<td>RME</td>
<td>Research, Monitoring and Evaluation</td>
</tr>
<tr>
<td>STAC</td>
<td>Scientific and Technical Advisory Committee</td>
</tr>
<tr>
<td>UCD</td>
<td>University of California Davis</td>
</tr>
<tr>
<td>UMCES-IAN</td>
<td>University of Maryland, Center for Environmental Science–Integration &amp; Application Network</td>
</tr>
<tr>
<td>USBR</td>
<td>US Bureau of Reclamation</td>
</tr>
<tr>
<td>USFWS</td>
<td>US Department of Fish and Wildlife Service</td>
</tr>
<tr>
<td>WDFW</td>
<td>Washington Department of Fish and Wildlife</td>
</tr>
</tbody>
</table>
Introduction

Purpose

Implementation of updates to the Bay-Delta Plan will require quantitative assessment of progress toward meeting the narrative objectives for protection of fish and wildlife. This will involve multiple linked elements that include biological goals, management questions, Delta and tributary specific monitoring plans, annual compliance monitoring reports, and an ecosystem-wide periodic comprehensive assessment report evaluating progress in meeting biological goals. The overall purpose of the implementation program is to determine the effect of flow and non-flow measures and ascertain whether satisfactory progress is being made or whether additional actions are required to recover native species and the ecosystem that supports them.

An independent science advisory panel (Advisory Panel) will be formed to provide advice on developing biological goals to support these implementation needs. The purpose of this report and accompanying document matrix is to inform and provide input on the program development process, format for biological goals and objectives, monitoring, reporting, and adaptive management.

Methods

The following methods were used to search for information on biological goals and objectives.

Research

Internet

ICF’s Corporate Librarian worked with ICF scientific staff to develop search strategies regarding information on biological goals and objectives: keywords to use, websites to search, and date and subject filters, such as finding items written in the “last xx years,” “Spring-Run Salmon,” and “Viable Salmon Population”.

The librarian then conducted an in-depth review of targeted web sites with similar biological goals, such as Columbia River Basin, Chesapeake Bay, and Upper Mississippi River. The librarian tracked search progress and findings in a spreadsheet with hyperlinks to web-based resources for replicability purposes.

After staff’s initial review, the librarian also followed up on citations from reviewed article/report references to locate additional promising articles and reports that were cited in retrieved materials.

Subscription Databases

The librarian also researched and retrieved articles and reports containing biological goal guidance using ICF subscription databases from EBSCO, such as Academic Search Complete and BIOSOS Previews. The librarian applied pre-determined search terms, dates, and other limiters such as publication type, similar to how the search was conducted on the internet.
Library

The librarian located books, articles and reports both within ICF’s own library in Sacramento, as well as at Sacramento Public Library and California State Library. The librarian also used inter-library loans to obtain/borrow non-local items such as environmental process books for ICF staff review.

Telephone

The librarian arranged telephone interviews between ICF scientific staff at government agencies and organizations and one of ICF’s fish biologists. The librarian located staff members to interview via internet research, emails and phone calls. ICF’s fish biologist used the interviews to understand how other agencies developed biological goals (e.g., processes used, methods employed for data analysis and interpretation, lesson learned) and to obtain additional sources of program documentation.

Documentation

The information collected in documents was reported in a matrix created in a Microsoft Excel spreadsheet (see Document Matrix file). This matrix summarizes key information on the documents, such as relevance to the current effort and page numbers for important information, as well as citation and website information. The document matrix is provided to the Panel as a supplemental material to support and assist their review of the SWRCB Biological Goals Charge.

Copies of publicly available documents are also provided to the Panel to aid in their review. Key information in many of these documents has been highlighted.

Final Sorting

Information was sorted into three categories: primary resource documents, secondary resource documents, and other potentially useful documents. The matrix has a separate worksheet for each category.

Primary Resource Documents

The information most directly relevant to the Advisory Panel’s work was categorized as Primary Resource Documents. Most of these documents are reports, telephone call summaries, and emails from three programs similar to the SWB’s Bay-Delta Program. These programs are the Puget Sound National Estuary Program, the Columbia River Basin Fish and Wildlife Program, and the Chesapeake Bay Program.

Secondary Resource Documents

Information that was considered relevant but more general as the primary resource documents was categorized as Secondary Resource Documents.

Other Potentially Useful Documents

Information that was considered somewhat or potentially useful was categorized as Other Potentially Useful Documents.
Results

Primary Resource Documents

This section summarizes information on the three programs found to be most useful to the Advisory Panel and relevant to the SWB’s Bay-Delta Plan Updates: the Puget Sound National Estuary Program, the Columbia River Basin Fish and Wildlife Program, and the Chesapeake Bay Program.

A series of questions were developed to gather information relevant to the Advisory Panel’s work. After an overview of the program, the responses to these questions are presented. These responses are based on telephone conversations and emails with staff and information contained in documents and on their websites.

Puget Sound Watershed

Overview

The Puget Sound Partnership (Partnership) is the Washington state agency that leads the region’s collective effort to restore and protect Puget Sound, which includes the Puget Sound National Estuary Program. The Partnership is tasked to bring together partners around a common action agenda, and advance sound investments and priority actions.

The Partnership does not have regulatory authority but:

- Is the agency responsible for advancing and in some cases allocating recovery resources, based on a science-driven, prioritized system.
- Is tasked with informing decision makers.
- Coordinates a science-based system of measurement and monitoring to promote accountability, effectiveness, and progress.
- Mobilizes funding for local and regional partners and tries to remove financial, regulatory, and resource barriers for its partners.

The Partnership receives most of its funding from the federal Puget Sound National Estuary Program. The greater Puget Sound ecosystem recovery effort partners and funding includes local, state, tribal, and federal government funds, as well as nonprofits, businesses, and foundation contributions.

Project prioritization and the science used to develop priorities is mostly developed by local, state, tribes, and federal agencies. The Partnership does not conduct research or monitoring.
Relevant Information

Salmonids

What biological parameters were used to assess recovery of salmonid runs?

Three levels of biological parameters are used in the Puget Sound area: guidance from the Puget Sound Recovery Implementation Technical Team (PSRITT), the regional Puget Sound Partnership Vital Signs, and the regional Local Integrating Organizations (LIOs) plans.

PSRITT Puget Sound Chinook Salmon Recovery A Framework for the Development of Monitoring and Adaptive Management Plans provides a framework that, “is intended to help salmon recovery managers formalize their local-scale monitoring and adaptive management plans using a common approach”. Examples are provided of ways in which abundance and productivity indicators (Table 5 in the report) and spatial structure and diversity indicators (Table 6 in the report) might be determined through either direct measurement or calculations using other indicators. The report also provides an example of a viability table for three indicators associated with abundance and productivity (survival rate) for Chinook salmon, using the Skagit Chinook salmon recovery goals as examples (Table 20 in the report). The report is provided to the Panel as supplemental material to support and assist their review of the SWRCB Biological Goals Charge (ChinookRecoveryFrameworkTM130WebFinal.pdf).

The Partnership coordinated the development of a set of measures (Vital Signs) to gauge the condition of Puget Sound. According to the Vital Signs website (http://www.psp.wa.gov/evaluating-vital-signs.php) “The Vital Signs gauge the health of Puget Sound in a way that is scientifically valid and also resonates with the public. Tracking and reporting of Vital Signs is the foundation of the shared measurement system the Partnership relies on to show collective impact.” More information on the Vital Signs is available on their website at http://www.psp.wa.gov/vitalsigns/index.php.

Puget Sound recovery is organized around Local Integrating Organizations (LIOs) (state, counties, cities, tribes and federal) and salmon recovery watershed groups to align actions, coordinate actions among partners, and direct resources to advance the most important actions. The LIOs are developing local ecosystem recovery plans with guidance provided by the Partnership. More information is available in the file Puget Sound LIO Plan Guidance_Master_Version 2.0.pdf.

The intent is the LIO plans would have specific ecosystem protection and recovery goals and objectives specific to the local watersheds that are linked to the regional vital signs and regional recovery and protection. An example is the Snohomish-Stillaguamish LIO Ecosystem Recovery Plan is found in the file Puget Sound_Sno-Stilly LIO_Ecosystem Recovery Plan.pdf.

What methods used to measure each parameter?

Examples of ways to determine biological parameters for salmon populations are described in the PSRITT framework documents described above for biological parameters.

Methods to monitor populations vary widely among watersheds. Primary monitoring parameters in Puget Sound are number of adults returning subject to harvest, harvest numbers and rates, and number escaping to spawn in rivers. The composition of natural and hatchery origin fish in natural spawning is monitored in all populations using a variety of methods. In several Puget Sound watersheds, the tribes and state (Washington Department of Fish and Wildlife [WDFW]) operate
juveniles outmigrating. These data are used to develop indices of freshwater productivity (juvenile recruits per spawner) and capacity (maximum production potential). Absolute estimates of productivity and capacity are difficult to obtain because of traps are located in rivers and difficulties operating a trap during the entire migration period (can extend from January to August in some watersheds).

The ChinookRecoveryFrameworkTM130WebFinal.pdf provides examples of ways in which abundance and productivity indicators (see Table 5) and spatial structure and diversity indicators (see Table 6) might be determined through either direct measurement or calculations using other indicators. Table 20 provides an example of a viability table for three indicators associated with abundance and productivity (survival rate) for Chinook salmon, using the Skagit Chinook salmon recovery goals as examples. The framework is provided to the Panel as supplemental material to support and assist their review of the SWRCB Biological Goals Charge.

The NisquallyRiver_ChinookManagement Plan_Final_12042017.pdf describes the core monitoring programs, variables, and activities to evaluate progress of recovery of Chinook salmon in the Nisqually River (see Chapter 5 and Table 5-1).

**How was data analyzed?**

Data analysis methods are provided in the documents described above for biological parameters. Technical staff in the watersheds prescribe the monitoring methods and data analysis approach. Fish monitoring is performed by the tribes and WDFW. Habitat monitoring is performed by a combination of the tribes, state, and local governments (i.e., counties).

The NisquallyRiver_ChinookManagement Plan_Final_12042017.pdf has an example of a monitoring plan developed for Nisqually River Chinook salmon. The Nisqually Indian Tribe and WDFW are implementing this plan. Similar plans are available for all watersheds in Puget Sound with Chinook salmon populations. The management plan is provided to the Panel as supplemental material to support and assist their review of the SWRCB Biological Goals Charge.

**Did the program have recommended numeric goals?**

Numeric goals are documented in the reports prepared by the LIOs. Examples include the “Study Plan and Summary of Results for the Skagit River Estuary Intensively Monitored Watershed Project” and “WRIA 9 Strategic Assessment Report – Scientific Foundation for Salmonid Habitat Conservation”. Both reports are provided to the Panel as supplemental materials to support and assist their review of the SWRCB Biological Goals Charge. (file names Skagit_IMW.pdf and WRIA_Strategic_Assessment_Report_2005.pdf, respectively).

**What has been learned and how has program changed over time?**

The Partnership has documented information on lessons learned in the report “Application of the ‘Best Available Science’ in Ecosystem Restoration: Lessons Learned from Large-Scale Restoration Project Efforts in the USA Prepared in support of the Puget Sound Nearshore Partnership (PSNP)”. (file name PSNP_2004_lessonslearned) The report is provided to the Panel as supplemental material to support and assist their review of the SWRCB Biological Goals Charge. The Panel may also access the report on the web at: http://www.pugetsoundnearshore.org/technical_papers/lessonslearned.pdf. The
Skagit_IMW.docx file documents information on monitoring lessons learned associated with monitoring estuarine habitats.

**Ecosystem Processes**

The Washington State Department of Ecology is responsible for basic monitoring of water quality and freshwater and marine productivity indices (see [https://ecology.wa.gov/Research-Data/Monitoring-assessment/Puget-Sound-and-marine-monitoring](https://ecology.wa.gov/Research-Data/Monitoring-assessment/Puget-Sound-and-marine-monitoring)). The region is moving toward a more coordinated Puget Sound monitoring program to monitor marine conditions because of concerns over survival of salmonids. This effort is part of the Salish Sea, a marine water body that includes Puget Sound, marine survival project ([https://marinesurvivalproject.com/](https://marinesurvivalproject.com/)).

The region does not have a single reporting database for much of the data collected by local entities (tribes and local governments) from Puget Sound watersheds.

*What parameters did they use and why?*

The Salish Sea marine survival project web site ([www.marinesurvivalproject.com](http://www.marinesurvivalproject.com)) lists research projects underway. The focus of the studies are to evaluate salmonid prey in Puget Sound to understand marine survival.

*How have they analyzed the data?*

A variety of methods are used across the region. See the Salish Sea website for more details about the program.

*What did they learn and how have they changed the program over time?*

The Salish Sea program is fairly recent. The program was started in 2012 and research began in 2014. Therefore, it is too early in the program to provide lessons learned.

**Links and Documents**


Salish Sea Project: [http://www.marinesurvivalproject.com](http://www.marinesurvivalproject.com)

The following reports are provided to the Panel as supplemental materials to support and assist their review of the SWRCB Biological Goals Charge:

1. *Chinook Monitoring and Adaptive Management Toolkit (Version 3.0)* (file name Puget Sound Chinook M&AM Toolkit_3.0_Final)

Summary of Communications

An ICF fish biologist contacted Mr. Kollin Higgins, King County Water and Land Resources Division (Kollin.Higgins@kingcounty.gov; 206-477-4711).

Topics discussed included:

- WRIA 9 Habitat Plan
- Validation monitoring
- Independent scientific review
- Puget Sound Partnership

Mr. Higgins directed ICF to additional WRIA 9 links and documents (see WRIA 9.docx in the supplemental materials file)

An implementation tracking report is prepared every few years for the decision makers: (http://www.govlink.org/watersheds/9/plan-implementation/ImplementationProgressReport2015.aspx)

The status and trends technical report covers more topics and has much more detail than the aforementioned tracking report. It is revised on average every 5 years, although it is currently overdue because all efforts have been focused on the 10-year salmon plan: (http://www.govlink.org/watersheds/9/pdf/2014-MarineShorelineMonitRprt.pdf).

The best entry point into the WRIA 9 website, because it links to the primary science documents used in the recovery plan, is at http://www.govlink.org/watersheds/9/reports/default.aspx.

An overview of how salmon recovery planning has happened is at http://www.govlink.org/watersheds/9/plan-implementation/default.aspx.

Additional Links:

- Estuary and Salmon Restoration Program (ESRP): (http://www.pugetsoundnearshore.org/esrp/)
- Puget Sound Nearshore Ecosystem Restoration Project (PSNERP): http://www.pugetsoundnearshore.org/index.html

Columbia River Basin

Overview

Congress passed the Pacific Northwest Electric Power Planning and Conservation Act in 1980, which established the Columbia River Basin Fish and Wildlife Program (www.nwcouncil.org). The purpose of the program is "to protect, mitigate, and enhance fish and wildlife affected by
hydropower dams in the Columbia River Basin.” The program’s vision is “a Columbia River ecosystem that sustains an abundant, productive, and diverse community of fish and wildlife, supported by mitigation across the basin for the adverse effects to fish and wildlife caused by the development and operation of the hydrosystem.” The Northwest Power Council (Council) has an Independent Scientific Advisory Board (ISAB), which develops, reviews, and recommends modifications the scientific principles underlying the program.

The program is divided into four nesting geographic levels: basinwide, mainstem, subbasins, and other geographic scales. The 59 subbasins in the program each have a subbasin plan:

The key elements of a subbasin plan are a 10–15 year management plan, an assessment of the subbasin’s historical and existing conditions, and an inventory of past accomplishments. Each management plan contains a vision and biological objectives for that subbasin, and identifies specific actions necessary to protect, mitigate, and enhance fish and wildlife in that subbasin. The subbasin plans thus reflect local policies and priorities while remaining consistent with the basinwide vision, biological objectives, and strategies. The subbasin plans remain a fundamental part of the program.

The Council also established a high-level indicators (HLI) program (see Salmonids in following section).

The Columbia River Basin Fish and Wildlife Program, its HLI program, and the subbasin plans form three layers of data and reporting in the Columbia River basin.

**Relevant Information**

**Salmonids**

**What biological parameters were used to assess recovery of salmonid runs?**

The Columbia River Basin Fish and Wildlife Program has four themes and uses qualitative and quantitative biological goals and objectives and indicators to prioritize work and determine whether progress is being made toward achieving the program’s vision.

- **Theme One:** Protect and enhance habitat to provide a home for species
- **Theme Two:** Ensure species survival by promoting abundance, diversity and adaptability
- **Theme Three:** Compensate for a wide range of hydrosystem impacts
- **Theme Four:** Engage the public

The biological goals and objectives of the first three themes are directed primarily at salmonids. A description of the themes and an overview of the program’s goals and objectives are available at [https://www.nwcouncil.org/fw/program/2014-12/program/partthree_vision_foundation_goals_objectives_strategies/iii_goals_objectives/](https://www.nwcouncil.org/fw/program/2014-12/program/partthree_vision_foundation_goals_objectives_strategies/iii_goals_objectives/).

A detailed list of all 22 goals and their objectives and strategies are available at [https://www.nwcouncil.org/fw/program/2014-12/program/partseven_appendices/d_goals/](https://www.nwcouncil.org/fw/program/2014-12/program/partseven_appendices/d_goals/).
Quantitative objectives and indicators have been established for some goals, but many objectives and indicators are still under development. According to the website:

Working with others in the region, including the state and federal fish and wildlife agencies and tribes, other federal agencies and the independent science panels, the Council will oversee a regional process to survey, collect, identify, and refine a realistic set of quantitative objectives for program focal species and their habitat related to the four broad themes and program goal statements. Evaluating progress toward program goals and objectives will occur through the adaptive management strategy and will be reported using program indicators [see Tracking Status of the Basin's Fish and Wildlife Resources section].

In October 2009, the Council approved three high-level indicators (HLI) to be used to monitor the status and trend of focal species and the progress of the fish and wildlife program:

- abundance of fish and wildlife
- hydrosystem survival and passage
- Council actions

HLIs for abundance of fish and wildlife include:

- Salmon and Steelhead Returning to the Columbia River and Counted at Bonneville Dam, 1938-2017
- Percentage of Naturally-Produced Smolts Returning as Adult Fish, 1994–2015 (Smolt to Adult Returns)
- Percent of Total Naturally-Produced Snake River Fall Chinook Harvested, 1986–2016.

More information on the HLIs is available at https://www.nwcouncil.org/ext/hli/background.php. Data on the HLIs are reported annually and summarized in a Table of Indicators (https://www.nwcouncil.org/fw/hli/indicators/).
In addition, each subbasin also has its own set of objectives and measures, which are incorporated into a subbasin plan. Subbasins submit annual reports, which can be found at https://www.nwcouncil.org/fw/subbasinplanning/home/.

**What methods were used to measure each parameter?**

The methods used for the program's biological objectives and indicators, HLIs, and other programs are available at https://www.nwcouncil.org/fw/am/monitoring/.

The methods used in the subbasins monitoring are available in the individual subbasin reports at https://www.nwcouncil.org/fw/subbasinplanning/home/.

**How were data analyzed?**

The methods used to analyze the HLI data are available in reports for each HLI under “Show data table and citations.”

The methods used to analyze the subbasin data are available under each subbasin plan link (https://www.nwcouncil.org/fw/subbasinplanning/home/). For example, the methods used in the Asotin Subbasin are available in the Washington Department of Fish & Wildlife’s *Asotin Subbasin Aquatic Research, Monitoring and Evaluation (RME) Plan*, which is available at https://www.nwcouncil.org/media/19472/AppM_AquaticRME.pdf.

**Did the program have recommended numeric goals?**

In some cases, yes. See the individual program biological goals and objectives, HLIs, and subbasin plans described for the preceding question.

**Ecosystem Processes**

**What parameters did they use and why?**

The first theme of the program, Protect and Enhance Habitat to Provide a Home for Species, relates to ecosystem processes. See discussion and links in *Salmonids*.

**How have they analyzed the data?**

See discussion and links for the program and the subbasins in *Salmonids*.

**What did they learn and how have they changed the program over time?**

The program has several reporting programs, review requirements, and science/policy exchanges that include recommendations for improving the program. The reports prepared are available at https://www.nwcouncil.org/fw/program/2014-12/program/partseven_appendices/l_reporting/.

For example, the ISAB 2014 review of the fish and wildlife program (https://www.nwcouncil.org/media/7491618/isab-2018-3-review2014fwp23march.pdf) includes a list of recommended changes to program and points to the Critical Uncertainties Report (https://www.nwcouncil.org/media/29261/2006_3.pdf).
Links and Documents

Program overview: https://www.nwcouncil.org/fw/program/2014-12/program/

Biological goals and objectives: https://www.nwcouncil.org/fw/program/2014-12/program/partthree_vision_foundation_goals_objectives_strategies/iii_goals_objectives/

High-level indicators: https://www.nwcouncil.org/ext/hli/background.php

Table of HLI indicators: https://www.nwcouncil.org/fw/hli/indicators/.

Subbasin plans: https://www.nwcouncil.org/fw/subbasinplanning/home/.

Additional documents related to the Columbia River Basin are provided to the Panel as supplemental materials to support and assist their review of the SWRCB Biological Goals Charge.

Summary of Communications

An ICF fish biologist contacted Ms. Patty O'Toole (potoole@nwcouncil.org; 503-222-5161) and Ms. Nancy Leonard (nleonard@nwcouncil.org; 503-222-5161) at the Northwest Power and Conservation Council.

Topics discussed included:

- Columbia River Fish and Wildlife Program
- Biological goals/objectives
- Independent science advisory board
- Floodplain and primary production

Ms. O'Toole and Ms. Leonard provided a set of links to processes or products organized into three groups: biological objectives, monitoring of objectives, and floodplain restoration (see Columbia_NPCC.docx). In addition, they provided a table that outlines the timeline/processes that lead to the Program’s adopted objectives (see NPCC_Timeline.docx). Both documents are provided to the Panel as supplemental materials to support and assist their review of the SWRCB Biological Goals Charge.

Chesapeake Bay Program

Overview

Relevant Information

The original Chesapeake Bay (Bay) Agreement was signed in 1983 by the governors of Maryland, Pennsylvania, and Virginia; the mayor of the District of Columbia; the administrator of the U.S. Environmental Protection Agency (EPA); and the chair of the Chesapeake Bay Commission. Its purpose was to develop a cooperative approach to address pollution problems in the Bay. The 1987 Chesapeake Bay Agreement set the first numeric goals to reduce pollution and restore the ecosystem. In 2000, the Chesapeake 2000 agreement set a vision and established a strategy to guide restoration efforts through 2010. In 2009, the Chesapeake Bay Watershed Agreement was initially drafted and input gathered. It was signed in 2014:
Signatories included representatives from the entire watershed, committing for the first time the Bay’s headwater states to full partnership in the Bay Program. The agreement established 10 goals and 31 outcomes to restore the Bay, its tributaries and the lands that surround them.

The Chesapeake Bay Program's suite of indicators focuses on telling the progress being made towards the 2014 Chesapeake Bay Watershed Agreement, which includes 31 Outcomes under 10 different Goals, including Habitat, Fisheries, Literacy, Stewardship, Land Conservation, and Toxic Contaminants. The Program is a collection of workgroups organized under larger thematic teams. The Chesapeake Progress website is used to track or explain progress toward the Outcomes in the Agreement.

**Salmonids**

**What biological parameters were used to assess recovery of salmonid runs?**

The only salmonid addressed in the Chesapeake Bay program is the brook trout, which lives in clear, cold freshwater streams and rivers in undeveloped areas throughout the Chesapeake Bay watershed. The priority conservation strategies for brook trout are:

- Protect highly functional Wild Brook Trout Only patches from detrimental changes in land use and water use practices.
- Connect habitats that have a high likelihood of sustaining stable wild brook trout populations.
- Improve access to brook trout spawning and seasonally important habitats (e.g., coldwater refugia, wintering areas).
- Improve brook trout habitats that have been impacted by poor land and water use practices.
- Mitigate factors that degrade water quality.
- Enhance or restore natural hydrologic regimes.
- Prevent and mitigate the spread of invasives/exotic species into patches containing wild brook trout only.
- Re-introduce wild brook trout into catchments within Wild Brook Trout Only patches, where the species has been extirpated or an increase in genetic fitness of the population is needed.

Information on the brook trout program is available at

Brook Trout Outcome Management Strategy, 2015–2025:

Brook Trout General Information:

Brook Trout Work Plan:

**What methods were used to measure each parameter?**

The methods used are described in the links in the preceding section.
How were data analyzed?

The data analysis methods used are described in the links in the preceding section.

Did the program have recommended numeric goals?

Yes, but many of them are related to water quality and species not present in California. More information is available at https://www.chesapeakebay.net/what/what_guides_us.

Ecosystem Processes

The ecosystem indicators used in the Chesapeake Bay program are the portion of the program most relevant to the Bay-Delta.

What parameters did they use and why?

**Abundance Indices**—indicators of Blue Crab Abundance and Management. The Analysis [here](#) and Methods [here](#) documents tell how these measures are being used, but not why they were selected.

**Primary and Secondary Production**—no Program-wide tracking of phytoplankton or zooplankton, although it has been raised as a need by the Forage workgroup, to work toward “assessing the forage base” as called for in the [Forage Outcome](#) of the Agreement.

**Phytoplankton**—Virginia tidal waters has maintained a consistent phytoplankton monitoring program in the bay/tidal tributaries for about 30 years. Maryland had to withdraw support around 2010 due to resource decisions across the monitoring program, but has recently restarted some phytoplankton monitoring consistent with the historical protocols. Although application of different methods across state lines was a weakness leading to defunding decisions nearly a decade ago, those issues were not fully addressed in the restart of the plankton monitoring program in order to bring a unified picture to Bay assessments.

**Zooplankton**—Historical data on zooplankton exist from around 1985 up until around 2004. Several attempts have been made to restart a monitoring program—workshops, expert panels, NOAA review of the program needs—and there are pockets of support, but not a watershed-wide push for adding zooplankton monitoring back to the Chesapeake Bay Program long term water quality monitoring program. Challenges with the historical data due to methodological differences between the states. Ultimately, the combination of the cost of the program for perceived results, significant differences in lab methods, and a lack of widespread manager support due to a lack of connection to understanding what value zooplankton results provided to decision-making needs and policy-setting in the partnership compared to other monitoring programs (e.g. SAV, dissolved oxygen, nutrients, etc.) led to a decision to defund zooplankton monitoring and redirect funds ($400,000).

Program does track benthic index of biotic integrity (B-IBI) for tidal waters (follow the link at the bottom of the webpage) and streams—links provide an explanation of the data. Data can be examined by going to the [Chesapeake Bay Benthic Monitoring Program](#) webpage. B-IBI is used in freshwater streams to describe progress toward the Stream Health outcome. There are site scores, but there is no method yet for converting site scores into miles of impaired waters. That decision for a protocol to convert site results into stream miles of good/impaired waters is the focus of a workshop in April 2018. Annual B-IBI data for the Bay, but limited on analysis support. The
University of Maryland, Center for Environmental Science–Integration & Application Network (UMCES-IAN) uses the data for their annual Bay Report Card (https://ecoreportcard.org/report-cards/chesapeake-bay/).

**Chlorophyll a**—The Water Quality Standards Attainment indicator includes standards for chlorophyll a for some designated uses, and the Analysis & Methods document is a good starting point to learn about data collection and analysis, and has other potentially useful links and contacts.

**Harmful Algal Blooms (HAB)**—No Program-level indicator, but there is consideration in the future for developing an indicator of harmful algal blooms as they relate to climate—to be part of the work toward the Outcomes under the Climate Resiliency Goal of the Agreement. Currently working to determine a suite of climate indicators and, as part of that effort, have developed implementation plans that detail how the indicator might be constructed for the most appropriate use at Chesapeake Bay Program.

States conduct HAB-specific investigations that are not part of the Chesapeake Bay Program long term water quality monitoring program but that are necessary within states to regulate drinking water safety decisions/beach closure decisions/shellfish closure decisions. The resolution in space and time of the long term water quality monitoring program is ineffective at tracking HAB events for all but a small number of species because most events are local scale, short duration while the monitoring program was set up for seasonal and annual water quality tracking assessments. The rare HAB species that occasionally have widespread 4–6 week blooms have included *Prorocentrum minimum*, cyanobacteria - usually *Microcystis aeruginosa* (typically river specific not across the open waters of the Bay) and maybe *Alexandrium* and/or *Cochlodinium* in Virginia waters. Possible satellite image assessment in play now for chlorophyll a anomalies, but species assessments needed.

**Native to Nonnative Species Comparisons**—No Program-level indicator or index of invasive species. Could be tracked at the Program level if ever determined it was a big enough factor affecting ability to achieve Outcomes; so far it has been identified as a factor but not explained how or how much. Focus groups in the Chesapeake Bay Program partnership, such as the Invasive Catfish Species Task Force (https://www.chesapeakebay.net/who/group/invasive_catfish_task_force), have produced reports and management recommendations, but no systematic assessment across taxa. Scientific and Technical Advisory Committee (STAC) review of the Invasive Catfish Task Force report (https://www.chesapeakebay.net/documents/FINAL_STAC_Invasive_Catfish_Review_Report_11.7.14.pdf).

**How have they analyzed the data?**

Where methods of analysis are available, they have been noted in the preceding section. See also the program’s Monitoring webpage at https://www.chesapeakebay.net/what/programs/monitoring and its Data webpage at https://www.chesapeakebay.net/what/data.

**What did they learn and how have they changed the program over time?**

**Scientific and Technical Advisory Committee**—The Scientific and Technical Advisory Committee (STAC) http://www.chesapeake.org/stac/# provides scientific and technical guidance to the Chesapeake Bay Program (CBP) on measures to restore and protect the Chesapeake Bay. Since its
creation in December 1984, STAC has worked to enhance scientific communication and outreach throughout the Chesapeake Bay Watershed and beyond. STAC provides scientific and technical advice in various ways, including (1) technical reports and papers, (2) discussion groups, (3) assistance in organizing merit reviews of CBP programs and projects, (4) technical workshops, and (5) interaction between STAC members and the CBP. Through professional and academic contacts and organizational networks of its members, STAC ensures close cooperation among and between the various research institutions and management agencies represented in the Watershed. Links to all of the publications in the STAC publications database, including workshop results, technical reviews, and activity reports can be found here: http://www.chesapeake.org/stac/stac_pubs.php

Links

Chesapeake Bay Program home: https://www.chesapeakebay.net/.
Programs and projects: https://www.chesapeakebay.net/what/programs_projects.

Additional documents related to Chesapeake Bay are provided to the Panel as supplemental materials to support and assist their review of the SWRCB Biological Goals Charge.

Summary of Communications

An ICF fish biologist contacted Jennifer Greiner, Chesapeake Bay Program Liaison, with the U.S. Fish and Wildlife Service (jennifer_greiner@fws.gov; 410-267-5783); Laura Free, Indicators Coordinator, with the U.S. Environmental Protection Agency, Chesapeake Bay Program Office (Free.laura@epa.gov; 410-267-5713), and Peter Tango, Chesapeake Bay Monitoring Coordinator with the U.S. Geological Survey (ptango@chesapeakebay.net).

Topics discussed included:

- 1983 Chesapeake Bay Agreement and 2014 Chesapeake Bay Watershed Agreement
- Biological goals/objectives
- Independent scientific review
- Primary and secondary productivity
- Invasive species and community metrics

Ms. Greiner, Ms. Free, and Mr. Tango provided an overview of the Chesapeake Bay Program and numerous links pertaining to the topics described above (see Chesapeake.docx).

Secondary Resource Documents

Secondary resource documents contain information that was considered relevant but more general than the primary resource documents. These documents are catalogued in the Document Matrix, which contains bibliographic and geographic information; a synopsis of key information; bundle type and species information; and a description of the relevance of the information to the SWB
project. These documents are provided to the Panel as supplemental materials to support and assist their review of the SWRCB Biological Goals Charge.

Examples of secondary resource documents include reports on conservation plans in California, adaptive management plans and strategies, salmon recovery plans, and other recovery goals and plans.

**Other Potentially Useful Documents**

Other potentially useful documents contain information that was considered somewhat or potentially relevant. These documents are also catalogued in the Document Matrix but with somewhat less detail than the secondary resource documents. These documents are provided to the Panel as supplemental materials to support and assist their review of the SWRCB Biological Goals Charge.

Examples of other potentially useful documents include reports on viable salmon populations, study designs, adaptive management, and planning.

**Native Fish Monitoring in the Bay-Delta**

**Native Fish**

Has anyone done anything similar to Moyle’s Suisun Bay fish and invertebrate sampling program?

Yes, the Hobbs lab at UC Davis has a very similar fish and invertebrate sampling program to Peter Moyle’s group, but uses a more extensive sampling protocol for identifying secondary production within the South San Francisco Bay and the North San Francisco Bay. [http://www.hobbslab.com/](http://www.hobbslab.com/)

**IEP**

The IEP fish monitoring program elements contain 16 surveys that are conducted by 5 organizations including: California Department of Fish and Wildlife (CDFW; formerly California Department of Fish and Game [DFG]), California Department of Water Resources (DWR), University of California Davis (UCD), US Bureau of Reclamation (USBR), and US Department of Fish and Wildlife Service (USFWS).

1. Delta Juvenile Fishes Monitoring Beach Seine (Beach Seine Survey) (USFWS): [https://www.fws.gov/lodi/juvenile_fish_monitoring_program/jfmp_index.htm](https://www.fws.gov/lodi/juvenile_fish_monitoring_program/jfmp_index.htm)
5. Delta Smelt 20 mm Survey (20 mm Survey) (CDFW): [https://www.wildlife.ca.gov/Conservation/Delta/20mm-Survey](https://www.wildlife.ca.gov/Conservation/Delta/20mm-Survey)


8. Suisun Marsh Fish Community Survey (Suisun Marsh Survey) (UC Davis): https://watershed.ucdavis.edu/user/53/library


11) Delta Shoreline Resident Fishes Survey (Resident Fishes Survey) (CDFW): No web page


Table 1 summarizes the program elements for the IEP fish monitoring program (Honey et al. 2004).
## Table 1. Program Element Descriptions for the IEP Fish Monitoring Program

<table>
<thead>
<tr>
<th>Program</th>
<th>Agency</th>
<th>Mandate information</th>
<th>Design</th>
<th>Years surveyed</th>
<th>Months</th>
<th>Survey interval</th>
<th>Gear</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Survey Group 1: Multiple, fixed location sampling</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Beach Seine Survey</td>
<td>USFWS</td>
<td>Soft mandate in NOAA OCAP as part of Oct-May RTM</td>
<td>Systematic</td>
<td>1976 to present</td>
<td>All</td>
<td>Weekly</td>
<td>Beach seine</td>
</tr>
<tr>
<td>2. San Francisco Bay Study</td>
<td>CDFW</td>
<td>Soft mandate in water rights decision D 1641</td>
<td>Systematic</td>
<td>1980 to present</td>
<td>All</td>
<td>Monthly</td>
<td>Otter trawl, midwater trawl</td>
</tr>
<tr>
<td>5. 20 mm Survey</td>
<td>CDFW</td>
<td>Spring 2004 OCAP for delta smelt</td>
<td>Systematic</td>
<td>1995 to present</td>
<td>Mar-Jul</td>
<td>2 weeks</td>
<td>20 mm</td>
</tr>
<tr>
<td>6. Spring Kodiak Trawl</td>
<td>CDFW</td>
<td>Spring 2004 OCAP for delta smelt</td>
<td>Systematic</td>
<td>2002 to present</td>
<td>Jan-Apr</td>
<td>2 weeks</td>
<td>Kodiak trawl</td>
</tr>
<tr>
<td>8. Suisun Marsh Survey</td>
<td>UCD</td>
<td>Soft mandate in D 1641</td>
<td>Systematic</td>
<td>1980 to present</td>
<td>All</td>
<td>Monthly</td>
<td>Otter trawl, Beach seine</td>
</tr>
<tr>
<td>9. NBA Survey</td>
<td>CDFW</td>
<td>Pilot study for broad, within-delta larva survey is mandated in spring 2004 OCAP for delta smelt</td>
<td>Systematic</td>
<td>1995 to 2004</td>
<td>Feb-Jul</td>
<td>2-4 days</td>
<td>Plankton net</td>
</tr>
<tr>
<td>Program</td>
<td>Agency</td>
<td>Mandate information</td>
<td>Design</td>
<td>Years surveyed</td>
<td>Months</td>
<td>Survey interval</td>
<td>Gear</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>----------------</td>
<td>-------------------------</td>
<td>----------</td>
<td>---------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>10. Smelt Larva Survey</td>
<td>CDFW</td>
<td>Study provides near real time distribution data for Longfin smelt larvae</td>
<td>Systematic</td>
<td>2009 to present</td>
<td>Jan-Mar</td>
<td>Semi-weekly</td>
<td>Egg and Larva net</td>
</tr>
<tr>
<td>12. SWP and CVP Fish Salvage</td>
<td>CDFW</td>
<td>Spring 2004 OCAP for delta smelt</td>
<td>Temporally systematic</td>
<td>1979 to 1992 involved less comprehensive sampling compared to post-1992 to present</td>
<td>All</td>
<td>Daily from as frequent as hourly counts</td>
<td>Screened louvers and holding tanks</td>
</tr>
<tr>
<td>13. Chipps Island Trawl</td>
<td>USFWS</td>
<td>Soft mandate in NOAA OCAP as part of Oct-May RTM</td>
<td>Temporally systematic</td>
<td>1976 to present</td>
<td>All</td>
<td>2-3 days (daily May-Jun)</td>
<td>Midwater trawl</td>
</tr>
</tbody>
</table>
What metrics did they use and why?

Catch-per-unit-effort (CPUE). CPUE is used because it is the easiest to quantify and expand over a larger area and allows for comparative analysis across studies using the same survey methods.

What did they learn and how has the program changed over time?

Studies have been used to create indices of abundance that have tracked fish abundance over time for specific endangered or threatened species.

What are current studies in the Bay-Delta monitoring native and non-native comparisons?

Moyle’s Suisun Marsh Study and Jim Hobbs’ South Bay, Napa Marsh, Sonoma Marsh and Petaluma Marsh studies monitor all fishes. The CDFW San Francisco Bay Study also records all fish caught. Data from all these studies could be used to compare native and non-native fishes.

Which habitats and locations are these studies taking place?

All habitats within the Sacramento and San Joaquin Rivers and Delta have been monitored by different methods over time, but none consistently except for the IEP studies monitoring pelagic fishes that are endangered or threatened. Moyle’s group has monitored Suisun Marsh consistently since 1976, Jim Hobbs has monitored the South Bay since 2010 and Napa, Sonoma, and Petaluma Marshes since 2014. CDFW has consistently monitored San Francisco Bay except for small gaps since 1980.

Are there certain locations we need to start monitoring more or at all?

ICF fish biologists suggest that a resident fishes monitoring program with fixed sites carried out throughout the Sacramento and San Joaquin Rivers and Delta would give the best data on native fish trends. To our knowledge, no sampling like this has ever been done comprehensively in these watersheds and the Delta. Equally as important would be sampling of the marshes surrounding San Francisco Bay.

How do you measure fish productivity? Native to invasive species comparison (biomass, numbers)? Native fish diversity index?

ICF fish biologists suggest that fish productivity can be measured by how many fish have reached reproductive age. In addition, total numbers expanded over habitat area would be a good comparison of native and nonnative fishes. A watershed Index of Biotic Integrity (IBI) could possibly be developed by incorporating a large number of site evaluations over a prescribed area then using the mean of all IBI’s for each site combined. Metrics developed using native fish biologists’ expert opinion and then tested to measure their sensitivity to change in native fish numbers, would be another way of comparing the overall health of the native fish population.
References Cited