Monitoring a natural resource like habitat or a fish species requires a wide range of data management functions. These functions include:

- defining the monitoring program’s objectives
- designing a study to meet those objectives
- documenting its protocols and methods
- obtaining or defining a set of sample sites to monitor
- supporting pre-season planning of crews & resources
- supporting logistics of data collection (including various devices to be used in the field)
- capturing details about the sites or samples where measurements were taken
- verifying data quality
- storing the data (measurements) so that it can be readily accessed
- calculating metrics and indicators from the measurements
- sharing the measurements, metrics, and indicators

The diagram to the left illustrates these different functions.

Typically these functions are supported by a series of documents and spreadsheets – unstructured data that works for small teams who don’t need to share or scale their processes and resulting data.

IDEALLY, each aspect of running a monitoring program is supported via a network of integrated systems. Separating the functions makes the problem space smaller and easier to solve for each system, letting each system excel at its assigned function and enabling all the systems to evolve more or less independently.

Done correctly, the result is a consistent user experience with uniform guidance and an order-of-magnitude increase in productivity for both monitoring practitioners as well as funders, regulators, and managers.

- **Monitoring Practitioners** can enter/provide information about their monitoring programs once, and have it shared many times. They also can leverage work of their peers and hopefully avoid over-monitoring some sites and under-monitoring others.
- **Funders, Regulators, and Managers** can more quickly review existing and proposed monitoring programs, better understand gaps and overlaps in monitoring at a regional scale, and make more timely decisions based on best available information. In short, they can make best use of limited funds.
This system supports a set of watersheds that are implementing the CHaMP protocol. Being on the leading edge of web-based monitoring system development, it supports a wide range of functions, some of which should ultimately be program “agnostic.” Today its functions include: user account management, program overview and outreach, program document management and training, details of each watershed’s spatial and temporal design (statistical frame, stratification, panels), site evaluation and export, measurement data upload, data quality, metric calculation, and data storage/sharing.

salmonmonitoringadvisor.org
Today this system is a training/education resource aimed at helping monitoring practitioners design and implement monitoring programs. While it has fantastic content that can really help raise the bar of monitoring across the region, it is not integrated with any other systems today, and therefore is an asset that the region is not leveraging.

monitoringmethods.org
Today this system catalogs over 450 protocols and 875 methods. It is being used primarily by BPA’s Research, Monitoring & Evaluation program within its Fish & Wildlife Division. It also stores a taxonomy of metric and indicator categories and a catalog of data repositories, and provides a suite of web services that other regional systems are starting to use.

Functionally, it supports aspects of defining a monitoring program and some of a monitoring protocol’s study design, stopping short of trying to capture the finer details of the spatial design (e.g. how the study’s samples are stratified, which exact samples or sites will be monitored, etc.).

champmonitoring.org
Today this system supports a set of watersheds that are implementing the CHaMP protocol. Being on the leading edge of web-based monitoring system development, it supports a wide range of functions, some of which should ultimately be program “agnostic.” Today its functions include: user account management, program overview and outreach, program document management and training, details of each watershed’s spatial and temporal design (statistical frame, stratification, panels), site evaluation and export, measurement data upload, data quality, metric calculation, and data storage/sharing.

mastersample.org
Today this system supports a set of watersheds that are implementing the CHaMP protocol. Being on the leading edge of web-based monitoring system development, it supports a wide range of functions, some of which should ultimately be program “agnostic.” Today its functions include: user account management, program overview and outreach, program document management and training, details of each watershed’s spatial and temporal design (statistical frame, stratification, panels), site evaluation and export, measurement data upload, data quality, metric calculation, and data storage/sharing.
Since data repositories are legion and dispersed across various agencies and organizations, we haven’t vetted that with organizations like WA Ecology, OWEB, ONRI, etc.

**Caveat:** This is still very BPA

Getting to the ideal isn’t something we can do overnight. This page suggests some potential next steps for everyone’s consideration. Something to get the conversation started...

- Create MR as the new hub of regional monitoring systems. Support central user mgmt and single sign-on; integrate with all the other systems.
- Merge content from salmonmonitoringadvisor.org (SMA) into a “training” or “primer” area of MR, making it not salmon-centric.
- Eventually, could support automatically generating metadata records (e.g. FGDC or ISO compliant) for datasets from this central hub. The “metadata builder pilot” project will help us understand the feasibility and relative value of mining these integrated systems and automatically generating metadata records.

- Move “Monitoring Programs” and User Profiles, Organizations, Community Discussions/Forums from MM to MR. To support monitoring programs using GRTS, provide a linkage from MM to MoS, encouraging the user to detail their sample design in MoS and use it to get the list of samples (sites) for their study. After #4 below is done, come back to MM and add support for monitoring programs using other, non-GRTS spatial/sample designs (including Opportunistic and other Probabilistic designs), by providing a linkage from MM to MoS. Similar to above, it should encourage the user to get their list of samples (sites) from MoS, or to log their list of sites with MoS.

- Build mastersample.org (MaS) and integrate it with other systems. Includes moving the “design documentation” tables out of champmonitoring.org (CM) into this new tool. Need to support a monitoring program having multiple sample designs. Over time, this could be expanded or augmented to support documenting effectiveness or mechanistic monitoring (e.g. documenting a BACI design).

- Build monitoring/sites.org (MoS) and integrate it with other systems. Specifically, move the “site evaluation” functionality in CM into this new tool. Make sure any site-level descriptions, ratings, driving/hiking instructions, landowner permission details/conditions captured by CM make their way into MoS. Needs to support a user uploading the sites they’ve already sampled. System needs to be sophisticated enough to identify “near duplicates” (ask user if their site is in fact same as another site, and if so, merge information about the site).

- Partially covered above, need to move functions currently in champmonitoring.org (CM) to the appropriate system. For example, program overview info, training materials, documents, need to move to MR; site evaluation needs to move to MoS; design documentation needs to move to MaS.
- If folks agree on a common set of needs for implementing a monitoring program, then we could turn champmonitoring.org into a more generic tool that could support N-number of monitoring programs (monitoringimplementation.org).

Since data repositories are legion and dispersed across various agencies and organizations, and since data producers/owners are loathe to relinquish control, we are unlikely to be successful trying to centralize all monitoring data (measurements, metrics, indicators).

However, we think we can centrally manage and share some datasets – those funded entirely by BPA from programs like CHeAMP and ISEMP. It is likely we can leverage the work already done in the STEM datastore currently hosted at NOAA.

For real adoption of central data repositories, we must make them easier to use and/or provide significant benefits over managing data in spreadsheets.
The image to the left is simply a conceptual piece to help suggest a few things:

- **Single sign-on** – users would have one account that would get them into various systems, but their exact permissions in those systems would be controlled by the admin of those systems.
- **Users would not necessarily need to know they were moving from one system to the next** – ideally, this would be seamless to them.
- **Users would always start by defining a monitoring program** (sorry, not shown here).
- **A Monitoring Program is a parent or umbrella object that holds the keys to other systems.** For example, Monitoring Program 19 is…
  - ... based on Protocol 57
  - ... uses Sample Design 13 (based on Master Sample 2)
  - ... involves Sites 518, 653, ...
  - ... is supported by Implementation Program 34
  - ... produced Datasets 47, 89, 213, ...

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**Monitoring Program 19**

- **Protocol 57**
- **Sample Design 13**
- **Involves Sites 518, 653**
- **Supported by Implementation Program 34**
- **Produced Datasets 47, 89, 213**
Data Sharing Challenges

- Inconsistent Data Formats
- Inconsistent Methodologies
- Inconsistent Analysis Procedures
- Inconsistent Semantics

Common Challenges

- Lack of documentation
- Data entry forms that meet local expectations
- Data integration across multiple databases
- Endless tail-chasing
- Lack of policy-level support
- Difficulties with funding and contracting

Data Flow “Desired State”

Determine a “Common” Vocabulary Across The Region

Proper QA/QC

Current State of Work Flow

Excerpted from a presentation done a year or so ago, these slides illustrate that the monitoring community has grappled with the challenges of data management for a while. These slides suggest some “Common Challenges,” some of which would be addressed by the architecture described in this broadsheet. They also propose a fairly uniform, “Data Flow Desired State” for managing the data generated by a monitoring program. Such a data flow could be enabled/supported by the architecture described in this broadsheet’s functional diagrams.

As to the “Current State of Work Flow,” it is nice to note that PNAMP, BPA, and CHaMP have collectively started to work on them. Specifically:

- monitoringmethods.org is improving documentation or metadata on protocols and methods.
- champmonitoring.org provides a central place to store monitoring measurements and metrics and enforces QC and QC of that data. However it supports just one monitoring program today.