PACIFIC STATES MARINE FISHERIES COMMISSION FINS DATABASE PROJECT

Technical Summary

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Fish Inventory System (FINS)

1 Introduction

FINS is the Fish Inventory System, managed under the aegis of the Pacific States Marine Fisheries Commission (PSMFC), the purpose of which is to provide a means for data collection on anadromous fish from geographically/temporally diverse sources and storage/retrieval in and from a single data source. FINS incorporates as a standard the ability to adapt to both changing user requirements and a continuing heterogeneity of user groups.

FINS consists of two main components, namely, a web presence and an offline component. Introduction of fish data to the FINS database and retrieval of fish data from the database is exclusively through the FINS website.

1.1 Web presence

The FINS web component for online user interaction is accessible at the url http://www.finsnet.org, or simply finsnet.org. The FINS web component also exposes various RESTful API, designed for automated data retrieval.

1.1.1 User interaction

User interaction with FINS through the website is by means of two separate areas (pages), referred to as FINSNet and FINS Online. FINSNet consists of a number of tabs that provide general information about FINS, training videos, access to FINS data, import of FINS data, and administration, as well as the ability to enter configuration information for various hatchery uses. This information consists of workflows or presets, that condition the usage of FINS by users entering data.

FINS Online is accessible by clicking the FINS logo on the main login page. Hatchery data is typically entered through access to FINS Online, and queries are available through FINS Online for the purpose of QA of data entered.

FINS is developed to target the Chrome or Brave browsers, so it is recommended to use one of these browsers with the FINS website.

1.1.2 API

A server-side web API is a programmatic interface, consisting of one or more publicly exposed endpoints. It defines a request-response message system and is generally oriented to a single

purpose. An API typically does not require or use a graphical interface, and can be used with essentially any client platform OS.

At present, data accessible through the FINS API consists of Trapping, Spawning, and Release data. The FINS API supports query string parameters for filtering the data retrieved, such as start and end dates and to scope the download to a single hatchery or an entire domain.

1.2 Offline component

FINS Offline is a desktop application that enables input of trapping and spawning data at remote locations without internet connectivity. The installer for the offline application is available for download from the FINS website.

Data entered through the offline application can be exported to a static file which is then uploaded to the FINS data repository through the FINSNet Data tab on the main web page.

2 Background

FINS and FINSNet.org grew out of a requirement for a database supporting a single version of data (one that is always current) which also supports data integrity through a robust backup mechanism, which can be simultaneously accessed by multiple users at any time.

FINS allows hatcheries to maintain their own fish data through a central data repository, with both data entry and data retrieval being autonomous and at the demand of hatchery personnel. Originally this was accomplished through a desktop application, which would accept data locally and later upload the data to the central repository.

This function was soon replaced by the FINSNet.org website through which data can be entered and retrieved from anywhere in the world, provided one has an internet connection (with provisions for entry of data for later upload, if one does not have an internet connection).

3 Solution

The features and functionality of FINS are developed through collaboration with users from varying perspectives and across multiple Agencies. This ensures broad coverage of programs and widespread applicability. Over time, user groups have been simplified into a Technical Advisory Committee (TAC) format for scope and requirements of the data collection process for components in development. FINS planned project implementations have Beta releases built into the schedule to solicit feedback and confirm with FINS users and TAC Members that needed elements are included and to test the performance and feature scope delivered.

The FINS solution consists of the FINS website http://www.FINSNet.org, together with attendant desktop applications whose purpose is to facilitate entry of data into the FINS data repository.

3.1 FINS website

The FINS website consists of a single page app, hosted at FINSNet.org on an IIS (Internet Information Services) server located at PSMFC headquarters in Portland, Oregon. The FINS site is implemented in part via the Microsoft technologies of ASP.Net - ASP.Net MVC, in combination with other server and client technologies such as AngularJS, Angular, Telerik/Progressive Kendo UI for JQuery, and Kendo UI for Angular all of which support the UI portion of the FINS user interface. FINS is currently a hybrid AngularJS/Angular application and is in the process of transitioning to a purely Angular web application. All of the technologies used by FINS are periodically updated on a schedule that is typically restricted to major revisions, and is tailored to keep user disruption to a minimum.

The FINS website is continuously monitored using the SmartBear AlertSite application performance monitoring tool, which is a third party platform that transmits alerts to the FINS team in the case of events such as a site down.

3.1.1 ASP.Net

ASP.NET is an open-source server-side web-application framework designed for web development to produce dynamic web pages. It was developed by Microsoft to allow programmers to build dynamic web sites, applications and services[1].

ASP.NET is a web development platform, which provides a programming model, a comprehensive software infrastructure and various services required to build up robust web applications for PC, as well as mobile devices.

ASP.NET works on top of the HTTP protocol, and uses the HTTP commands and policies to set a browser-to-server bilateral communication and cooperation.

ASP.NET is a part of Microsoft .Net platform. ASP.NET applications are compiled codes, written using the extensible and reusable components or objects present in .Net framework. These codes can use the entire hierarchy of classes in .Net framework.

The ASP.NET application codes can be written in any of several languages, the principal one for FINS being C#[2].

3.1.2 ASP.Net MVC

MVC is a design pattern used to decouple user-interface (view), data (model), and application logic (controller). This pattern helps to achieve separation of concerns.

Using the MVC pattern for websites, requests are routed to a Controller that is responsible for working with the Model to perform actions and/or retrieve data. The Controller chooses the View to display and provides it with the Model. The View renders the final page, based on the data in the Model[3].

3.1.3 AngularJS

AngularJS, otherwise known as Angular 1, is a library written in JavaScript.

AngularJS is a structural framework for dynamic web apps, allowing use of HTML as the template language and extends HTML syntax to express application components clearly and succinctly. AngularJS's data binding and dependency injection eliminate much of the code that would otherwise have to be written[4].

3.1.4 Angular

Angular, otherwise known as Angular >1 is a web development platform that is node[5] based. Angular[6] is a development platform built on TypeScript that includes:

- A component-based framework for building scalable web applications
- A collection of well-integrated libraries that cover a wide variety of features, including routing, forms management, client-server communication
- A suite of developer tools for code development, build, test, and update

3.1.5 Kendo UI for JQuery

Kendo UI for jQuery[7] provides integration with AngularJS. The suite includes widgets for enterprise-grade line-of-business applications and is suitable for creating professional websites. Widgets provided by the suite include Data Grids, List Views, Tree Views, Popup windows, as well as objects such as DateTime pickers.

3.1.6 Kendo UI for Angular

Kendo UI for Angular[8] is the corresponding node based suite of UI widgets compatible with Angular, and containing components of analogous function and similar appearance to those of Kendo UI for jQuery. Kendo UI for Angular contains over 100 UI components.

3.1.7 FINS user interface

The FINS user interface consists of two logical divisions, presented as different pages, namely, FINSNet and FINS Online. These two subdivisions of FINS comprise the complete functionality for entering data into and for extracting data from the FINS data repository.

3.1.7.1 FINSNet

The portion of the FINS user interface known as FINSNet is accessible directly from the FINS url http://www.finsnet.org and is the first or home page encountered when going to that url.

Access to FINS is controlled through user login. User accounts and initial passwords are assigned by request through the FINS team and product owner, following the Steering Committee member approval. Associated with each user account is a main role, corresponding to the functions a user will be accomplishing with FINS. For example, if the user role is Data Query, the user is allowed to query data but not enter it. If the role is Data Entry, the user is allowed to enter data as well.

The FINSNet page will present different views to different users, depending on role. The full suite (not all of which is visible to all users) of components/functions is presented in a number of tabs, namely Home, Products, About, Data, User, and Admin. The first three tabs are visible in the home page and do not require a login.

User login functions are protected by various crypto methods such as SHA-2 and using pseudorandom salting and key spreaders to thwart attacks. User passwords are not stored in the FINS database. These provisions are additional to more general FINS security protocols.

3.1.7.1.1 Home

The Home tab simply returns the user to the FINSNet home page, where the project is summarized for public view and the available tabs the user has access to if logged in are displayed.

3.1.7.1.2 Products

The Products tab will display, at a minimum, a short list of features of the FINS application. For a logged on user, the Products tab will also provide an expanded menu with download links for the FINS Offline installer, the PIT tag client application, information about the FINS API interface, and the What's New document, which is a word document chronicling changes and updates to the FINS application, supporting applications and/or the FINS database, and which is updated with each deployment by version.

3.1.7.1.3 About

The About tab is a fully public viewable menu that contains links to a number of pages detailing a summary of FINS features, the purpose of FINS, a review of the kinds of data that can be entered into and retrieved from the FINS database and the means of doing so, the structure of the FINS project, FINS development team information, details of the technologies used, the data use agreement/data sharing policy, and the FINS charter.

3.1.7.1.4 Data

The Data tab provides an interface to the FINS Query Tool, through which users can 1) engage in retrieval of much of the data kept in the FINS database, and 2) enter data in batch mode into FINS through a number of upload functions.

3.1.7.1.4.1 Retrieval

Retrieval of data through the FINSNet Data Tab Query Tool can be generally categorized as either query retrieval or summary retrieval, although there is some overlap of these categories.

Query retrieval is interpreted here to mean the download of 'raw' transactional FINS data, made available by assembling the data in a downloadable Excel spreadsheet, and comprised of a complete set of columns related to the particular request. Requests are typically for Trapping, Holding, Spawning, Incubation, Rearing, and Release data. Requests can be filtered by time interval, hatchery/facility, species, in addition to other criteria where applicable, such as incubation hierarchy (a particular arrangement of incubation rows, stacks and trays at a hatchery) or rearing array (a particular arrangement of vats, ponds and raceways at a hatchery).

Summary retrieval consists of data categorized in the same fashion as query data, i.e., as Trapping, Holding, Spawning, Incubation, Rearing, and Release, but rather formatted as a summary of the raw data.

The FINS Search tool is a component that allows retrieval of query (raw/transactional) data, but in a much more extensively filterable form, as well as the ability for FINS Search users to build their own summary from the results by means of ad hoc construction of pivot type presentations.

3.1.7.1.4.2 Upload

The Data tab also facilitates the nonmanual batch insertion of data into FINS by means of methods categorized as imports and offline uploads.

3.1.7.1.4.2.1 Imports

Imports, as defined for the Data tab, consist of uploading, verification, and committing FINS data in a batch mode, as an alternative to manual user input through various dialogs that would take place within FINS Online. Imports are useful for entry of historical/legacy data into FINS which may already be in spreadsheet form, but they can be used for input of current data captures as well. Imports also allow midstream data entry where PBT origination data may not have been collected, or where data

corresponds to a phase of collection beginning at a state beyond what is ordinarily captured, such as the import of incubation data without corresponding spawning data, or importing rearing data without either associated incubation or spawning data, into FINS.

An import is structured as an Excel spreadsheet with an explicit column set and cell data format. The specific formats required for each type of import are supplied as example validation sheets downloadable from links associated with the import to be referenced/used as an import template.

The import process consists of uploading the spreadsheet, which then goes through a process of validation to ensure that the data imported is consistent with current FINS data of the given type. If the import is valid, the user is presented with a preview of the imported data and is given the opportunity to commit the data to the FINS database. Otherwise, FINS will report validation errors that must be addressed before the import can succeed.

The import process can be used to add Trapping, Spawning, Incubation and Rearing data to the FINS data repository.

3.1.7.1.4.2.2 Offline uploads

Another means of inserting batched data into FINS is through offline uploads, which are distinct from imports in several ways. An offline upload consists of an upload and subsequent processing of a FINS Offline export file, which is an encrypted file containing the result of one or more sessions using the FINS Offline desktop application. These sessions typically take place in a remote environment without internet access. Session types supported are Trapping and Spawning with corresponding upload files. Users enter data into FINS Offline at a remote location for Trapping and/or Spawning, much as they would in FINS Online.

The resulting session data can then be exported to a file on a removable drive, which can then be transported to a location that has internet access for upload into FINS. The upload process will verify the type of data and present a preview of the data, which then can be committed to the FINS database, after which the status of the data is the same as any other data entered into FINS by any other method.

3.1.7.1.5 User

The User tab contains information which is either user related or which is useful to a particular user. Categories of user information consist of user permissions summary, locations, origins, seasons, and stocks. These categories for a user are those that are

associated with the hatchery/facility or agency the user is associated with. In the case of locations, this consists of traps, holding locations, spawning locations, incubation hierarchies, rearing arrays, and adult and juvenile release locations, as well as offsite locations, which are locations belonging to one facility for which there is an arrangement for use by another facility.

Origins consist of fish origin information (e.g., hatchery or natural, etc.) for origins associated with the user facility.

Seasons are those constructed for the use by an agency/facility and are general purpose date brackets used to condition/filter various queries and summaries.

Stocks are those belonging to an agency/facility for use in assignments typically during spawning, that are carried forward through incubation, rearing, and release.

The User tab also displays TAC contact details, and a Learning Resources section containing links to the FINS training calendar, FINS training video libraries, and FINS documentation. The User tab additionally shows permission permitting access for management data entry of percent saturation, and information on files uploaded through the FINS Portal.

User tab functions that are specific to a particular user are the ability to change the user password, and if the user has sufficient permissions, to also switch the facility/hatchery the user is associated with.

3.1.7.1.6 Admin

The FINS Admin tab generally contains the means to create and edit administrative information. The principal administrative categories are setup and the two workflow categories of adult workflows and subadult workflows. In this context, a workflow consists of information that conditions or constrains views or behaviors of dialogs in other areas of FINS, usually for an entire agency (a collection of facilities related in some way) or a particular facility/hatchery. The use of workflows allows FINS to have customizable appearance and behavior tailored to particular classes of users, without imposing a single user experience on all FINS users.

These three categories_are available to administrators, who are either certain FINS users with the appropriate permissions, or FINS domain administrators (restricted to PSMFC FINS team personnel).

3.1.7.1.6.1 Setup

The setup category contains links to dialogs related to managing users, locations, origins, stocks, and the custom trapping quick view.

The users dialog allows administrators to create new users and to view and edit current user information, such as FINS role, password, email, and agency or facility affiliation.

The locations dialog allows administrators to create new locations (including incubation hierarchies and rearing arrays), delete locations and edit current locations, as well as to create offsite relationships of locations to alternate facilities, or to mark locations as archived.

The origin dialog allows administrators to create new fish origins.

The stock dialog allows administrators to create new fish stocks.

The quick view dialog allows for the customization of the Trap Fish form.

3.1.7.1.6.2 Adult workflows

Adult workflows are those affecting FINS adult activities (Trapping/Holding/Spawning) involving fish, including the age criteria, common fish, move to locations, preferred identifiers, preferred UI, purposes, seasons and trap operations workflows.

3.1.7.1.6.3 Subadult workflows

Subadult workflows are those affecting FINS subadult activities (Incubation/Rearing/Release) associated with either eggs/fry or juveniles, including workflows for release groups, release types, seasons, and shed rate configuration.

3.1.7.1.6.4 Appropriate permissions

Within FINS, user permissions are by default role based, with roles assigned when a user account is created, or when user information is edited from the users form in the Admin tab. The current FINS user roles are Data Query, Data Entry, Data Coordinator, Facility Admin, Data Official, Facility Admin/Data Official and Domain Admin. FINS roles control what portions of FINS may be accessed, and what activities are available. For instance, a Data Query user will by default not have access to the Admin tab of FINSNet, and will only have permissions to query data and not to create data. The Domain Admin role is restricted to PSMFC FINS team personnel, and has essentially unrestricted permissions within FINS.

In addition to role based permissions, FINS user permissions are also governed by the extended FINS permissions structure, which is a mechanism available to designated PSMFC FINS team permissions managers, and can fully customize a particular user's permissions for essentially any FINS function. For example, a user can be granted the ability to change the facility or hatchery from the default, in order to view, create, or

edit FINS data for the new facility as well as the original facility. This functionality extends to users who enter data for multiple facilities. It is of course granted to particular users only at the request of the affected hatcheries or agencies.

Extended FINS permissions are supported by crypto methods in a similar fashion to user passwords, such that even with full knowledge of the FINS database, permissions are essentially impenetrable to a brute force attack.

3.1.7.1.7 Security protocols

PSMFC FINS Data Security Protocols

- PSMFC and FINS firewalls employ Intrusion Detection and Prevention systems, electronic communications between PSMFC and FINS offices is facilitated using Site-To-Site VPN tunnels leveraging encryption that exceed industry standards.

- FINS data is housed and maintained within PSMFC's internal data computer systems, these systems and user access adapt the "Principle of Least Privilege", therefore dictating who can view what data and separating data between individual users.

- To ensure data integrity, PSMFC/FINS applies security patches and upgrades, keeps virus software up-to-date on all systems on which the data may be used, conducts full backups of their databases weekly, incremental backups daily, and preserves an archive of monthly backups for 3 months.

3.1.7.2 FINS Online

The subdivision of FINS known as FINS Online is accessed from the FINSNet home page by clicking on the FINS logo. FINS Online is the FINS component typically used for manual data input into FINS. In addition to functions for manual input, FINS Online offers numerous query capabilities (similar to those offered by the Data tab of FINSNet, but more restrictive, limiting the data view per the facility the user belongs to) for the purpose of assuring the quality of data manually entered by the user.

3.1.7.2.1 Manual input

The majority of dialog windows for data entry into FINS is found within FINS Online, including resources for entering or editing data on trapped fish, spawned fish, moved fish (fish moved between holding locations, for example), moving eggs from spawning into incubation containers or between incubation containers, moving eggs from incubation containers into rearing containers, moving eggs from incubation containers into release locations, moving juveniles between vats, ponds, or raceways, and moving juveniles from

rearing containers to release locations.

There are numerous ancillary dialogs for such activities as manipulating trap operations, attaching identifiers to fish in holding containers, adjusting counts of fish in holding containers, picking egg morts, enumerating eggs (a one-time process associated with the physical activity of enumerating eyed eggs), enumerating juveniles (a one or more time process associated with adjustment of juvenile counts to accommodate such things as results from a marking trailer), attaching identifiers to juveniles (also related to marking trailer results), applying a shed rate to the juveniles in a container or containers, setting rearing metrics for juveniles in a rearing container, picking juvenile morts and adjusting identifier counts accordingly, associating juvenile containers with a release group, and searching a rearing array or incubation hierarchy for subadult or parent information.

3.1.7.2.2 Query capabilities

Query capabilities within FINS Online are typically restricted to data associated with a particular hatchery/facility (that of the logged on user) and can for efficiency be further restricted by the use of seasons (start and end date brackets). Users can manually enter data into a FINS dialog, and then immediately query the same data for QA purposes.

At present FINS Online offers queries for trapping, group trapping, trap status, moved fish (moving adult fish into/between holding locations), count corrections (inventory adjustment/correcting counts of fish in holding locations due to unknown factors, i.e., predation, etc.), receipts (of fish moved from one facility to another by means of a fish 'inbox' method), spawned or group-spawned fish, eggs/fry moved, egg/fry morts, egg enumerations, juveniles moved, juvenile morts, juvenile enumerations, juvenile identifiers, juvenile identifier shed rate, egg/fry releases and juvenile releases, as well as inbox contents for fish, eggs or juveniles.

3.2 Desktop applications

FINS desktop applications are Windows applications that assist input of data into FINS in some way. These are the FINS Offline installer and the PIT Tag Client, which can be downloaded directly from the FINS website (under the Products tab on the home page).

3.2.1 FINS Offline

The FINS Offline application is a Windows desktop application that has a similar look and feel to dialogs within FINS Online for manual input of trapping and spawning data, but is for use at a remote location without internet access, or a location with internet that has less than the FINS supported upload and download speeds (FINS requires a 2Mbps download connection at minimum).

The FINS Offline installer can be directly downloaded from the FINSNet website. Once installed, FINS Offline can be opened (while the installed platform, such as a laptop, has an internet connection) so the local database for the application can sync with the main FINS database. Once this has been done, the FINS Offline application can be taken to a remote site with poor or nonexistent internet, and trapping and/or spawning session input can be conducted just as would be done through FINS Online via an internet connection. The Offline data input is stored in the local database on the user's device. When it is desired/appropriate, the FINS Offline user can export all session data to a removable drive, which can then be transported to a device with internet, from which the exported data can then be uploaded into FINS (via the FINSNet Data tab offline upload function).

3.2.2 PIT Tag Client

The PIT Tag Client is a stand-alone executable that does not require an installer. It is a Windows application that interprets communication on either a serial (including Bluetooth) or USB port on the Windows device (a device running the Microsoft Windows operating system), from a connected PIT Tag reader (RFID reader), and further communicates with a FINS web dialog such as a Trap Fish dialog or with a Trapping session in the FINS Offline application.

The end result is that a PIT Tag is read directly from a fish into the FINS web application or into FINS Offline so that the PIT Tag value does not have to be manually entered, ensuring QA/QC, and auto entry for data collection at speeds necessary for trapping. All that is required for this to occur is that the PIT Tag Client be running and that the appropriate port be selected from those connected to the Windows device that the client discovers through the standard Windows port discovery process.

3.3 FINS data repository

The FINS data repository is a Microsoft SQL server[9] database hosted on a dedicated hardware server at PSMFC headquarters in Portland, Oregon on the PSMFC LAN. The server is owned and maintained by PSMFC. Communication with the database is exclusively through the FINSNet web server (http://www.finsnet.org) which runs on a second (also hardware) dedicated server, also situated at PSMFC headquarters in Portland and also owned and maintained by PSMFC. Both the FINS database server and the FINS web server are realized on hardware (as opposed to virtual) platforms by deliberate choice (following benchmark tests completed by the FINS team), because requests are fulfilled immediately and latency is reduced to a minimum.

No part of the FINS database is stored on third party cloud servers.

The FINS database currently consists of well over 350 tables, each of which is dedicated to a particular FINS requirement, such as locations, agencies, fish, eggs, juveniles, incubation hierarchies, rearing arrays, users, user permissions, user roles, and many others. The FINS database

is highly dynamic, in that most tables are constantly being added to or updated, and also in the sense that new tables, views, and stored procedures dedicated to new functionality are frequently added. The FINS database is subject to nightly backups, and these backups are also backed up in several different ways in geographically diverse locations and redundantly at these locations (in several states), such that in the worst possible case, FINS data can always be restored to within one day of any data-related disaster.

It is a FINS standard practice to retain user created data regardless of whether it is currently active or inactive (unless it is an easily recreated item such as a season that does not impact actual hatchery data). That is, data that is deleted by users, whether intentionally or not, is logically deleted only (as opposed to a hard, or physical deletion), and can be recovered at any time (though not necessarily through the FINS user interface). This adds another layer of data integrity/security. Data such as locations, fish, eggs, juveniles, incubation hierarchies, rearing arrays, and even records of moves between these, once created, is thereafter retained.

The FINS SQL database is monitored in a number of ways, namely using the Red Gate SQL monitor[10] which records and reports database events and also using the FINS Event Log, which records database events as well as web server events and even client/browser events.

4 Conclusion

FINS meets the dual requirements of a centrally located data repository for anadromous fish data such that geographically diverse hatcheries/facilities can both contribute to and retrieve data from the central resource in real time, and of a solution that is highly adaptable to varied user groups and varied user requirements.

FINS functionality is and will continue to be based on user (agency/hatchery/facility) input and was constructed to be entirely based upon and responsive to hatchery requirements. FINS is able to accommodate disparate user needs through the use of customizations such as workflows, and rather than attempting to be a one-size-fits-all solution, is capable of adapting/growing to address changing users and user requirements while maintaining consistency of current and legacy data storage.

5 Works Cited

1. https://dotnet.microsoft.com/apps/aspnet
2. https://www.tutorialspoint.com/asp.net/asp.net_introduction.htm
3. https://dotnet.microsoft.com/apps/aspnet/mvc#:~:text=Model%20View%20Controller%20(MVC),to%20achieve%20separation%20of%20concerns.
4. https://docs.angularjs.org/guide/introduction
5. https://www.tutorialspoint.com/nodejs/nodejs_introduction.htm
6. https://angular.io/guide/what-is-angular
7. https://docs.telerik.com/kendo-

ui/introduction#:~:text=Kendo%20UI%20is%20a%20comprehensive,high%2Dperformance%20websites%20and%20applications.&text=Kendo%20UI%20for%20jQuery%20provides,depending%20on%20your%20project%20requirements.
8. https://www.telerik.com/kendo-angular-ui/components/
9. https://en.wikipedia.org/wiki/Microsoft_SQL_Server
10. https://documentation.red-gate.com/sm