Klamath Basin Fisheries Collaborative

Lessons Learned
from Implementing Electronic Field Data Capture Workflow for the
Klamath Basin Fisheries Collaborative using Survey123 and Bluetooth Devices
(Version 1.0)

Introduction

This project contributed to improving fisheries data sharing by modernizing the data collection and exchange process used by participating Klamath Basin Fisheries Collaborative (KBFC) members. To cost-effectively implement and support a modernized data flow among participating KBFC members, the project focused on the data defined in the KBFC data exchange standards. It also aimed to standardize the process and tools (hardware and software) used by participating members to capture and exchange field data, to allow for reuse of forms, database schema, and data flow scripts among members. The observations below are based on the system development activities and pilot testing conducted by PSMFC staff and KBFC members.

KBFC Modernized Data Flow

The KBFC modernization data flow focused on evolving data capture from using paper data sheets in the field and from manually entering data into a member's local database and into the KBFC regional data system (Figure 1). Modernizing the field data capture provided the opportunity to standardize fields for data elements exchanged with the KBFC regional data systems across all participating members. The data elements focused on consisted of those included in the KBFC data exchange specifications that the KBFC members collaboratively developed (KBFC Controlled Vocab and Data Exchange Standards, current version accessible from the KBFC website's Resource section: https://www.kbfishc.org/).

To have a lower cost for the development, user support, and maintenance of the modernized data capture and flow process, participating KBFC members agreed to leverage tools included in their online ESRI license, specifically the ArcGIS Survey123 to generate electronic forms. To simplify user support, only two ArcGIS Survey 123 forms were developed to be used by all participating KBFC members, one to capture mark-recapture PIT tagged fish data and one to capture PIT tag remote detection data. For members interested in flowing these data from their ESRI online account to their local database, one database architecture was developed to house the KBFC data elements collected using the standard Survey 123 forms, which were deployed to these KBFC members. Similarly, the same custom scripts were shared with the participating KBFC members to download data from their ESRI account to the provided database, and to submit their data to the KBFC data system using the KBFC API. For members wanting to submit from ESRI directly to the KBFC data system using the KBFC API, another custom script was written and shared with them.

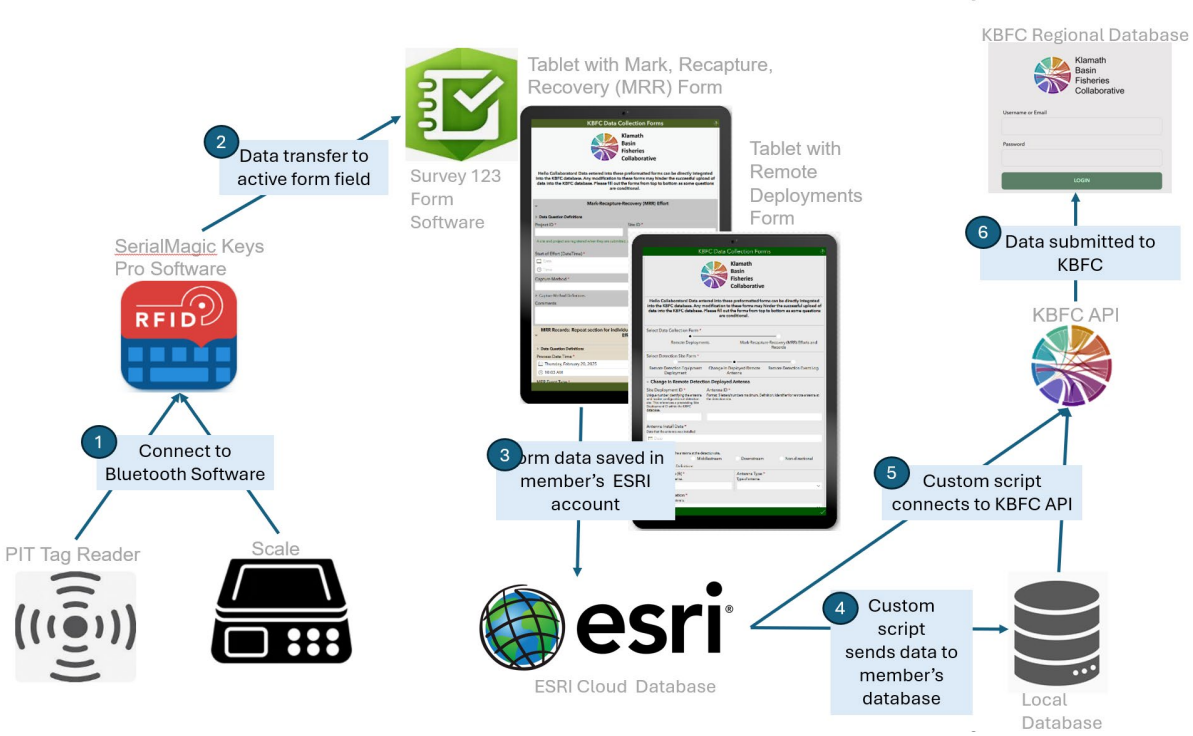

Figure 1: Modernized data flow from field data capture to submittal to the KBFC regional database.

Pilot Testing

Pilot testing was a critical part of the development and implementation of modernizing the data flow for KBFC data fields. As the availability of members' staff was restricted by their workload, a variety of approaches were used to observe users interacting with the new tools, including during in-person KBFC leadership team meetings, conducting in-person training within an office setting, providing in-person training and support with users in the field, and remote training and support through virtual meeting with screen sharing. Each of these approaches provided different level of insight into how to improve the technology. By far, the most valuable approach is to observe users interacting with the new technology as part of their workday, preferably while conducting fieldwork.

Initial approaches to pilot testing focused on individual components that aligned with the activity and interest of the user, such as testing how a user navigated one of the survey 123 forms on the tablet. This piecemeal approach resulted in some issues not being identified until much later in the process, such as incompatibilities between tablet-level field validations and API validation requirements. A more effective testing approach would have been to test all components of the data capture and exchange process within one test instead of evaluating individual components. Data needed to move through the full workflow, from field collection through ESRI cloud, local databases, and API submission, to allow us to identify issues with validation, formatting, and data exchange that occurred during the flow process.

A key part of this effort was identifying staff within KBFC member organizations to work directly with PSMFC staff. These individuals tested Survey123 forms, scripts, field workflows, the use of tablets, PIT tag readers, and scales. Having designated testers would have provided a more efficient and consistent way to gather feedback, whereas the opportunistic approach based on staff availability

resulted in a prolonged testing period with incomplete member-based user testing. Having a designated tester within each participating member would also have helped build familiarity with the system within each organization.

As some of the users recruited to test and provide feedback were not involved in the KBFC leadership team meetings guiding this work, they were not always informed about the development stage they were being asked to test. This caused some user frustration as some expected to be working with a finished production-level product and not the development version. When users understood they were testing a system to inform future improvements, and not a finished product, they were more effective in identifying and suggesting changes.

In addition to improving the system, pilot testing should serve to help organizations build internal capacity by having some staff more familiar with the technology and being able to assist their colleagues. Staff involved in testing often became key resources during implementation and supported other organization users during rollout.

Survey123 Form Development

Two Survey123 forms were developed for KBFC members. One form was developed to capture data about fish that are PIT tagged, called the KBFC Survey123 Form – MRR Efforts and Records, and the second to capture data about remote deployment sites installed for PIT tag detection, called the KBFC Survey123 Form – Remote Deployments and Event Log. Current versions of these forms are available from the Klamath Basin Fisheries Collaborative website under the Resources section https://www.kbfishc.org/.

Thoughtful form design is critical as it affects how easily users transitioned from paper to electronic data collection. Forms that closely matched existing paper datasheets were easier for users to adopt. This is due to the paper datasheets having evolved over time to best align with efficient field data collection processes. To ensure that the electronic data form integrates well with field data collection workflows, it is necessary to observe the biologists working in the field with the electronic form. Testing in field conditions provided the necessary insight to identify issues with layout, navigation, and usability that needed to be addressed to ensure user adoption.

When designing the form, it is also best to have regular engagement between the staff developing the form's validation rules and the staff developing the database and API validation rules, to review the work to ensure that the validation rules are compatible. Relying on the fields and validation rules described in the KBFC data specification can result in misinterpretations or omissions, requiring refinements to achieve alignment with the database or API requirements.

Determining whether one electronic form or multiple forms are needed is an additional challenge. When developing an electronic data form, it is important to keep in mind the workflow to inform how many fields to include in one form and how best to separate data fields across multiple forms. The more complex forms with additional fields or structure slowed data entry and created challenges in the field. However, if related fields are collected during the same event or sequence of data collection, it is more efficient for users to have those fields on the same form rather than needing to navigate to a different form, which can disrupt the field workflow.

For KBFC, we initially developed one form limited to the data elements included in the KBFC data exchange standards. After observing users in the field, additional related data elements were added to the form to better support their existing field data collection workflow. After interacting with biologists using the form that were focused on different fish species, it became apparent that developing multiple versions of the KBFC Survey123 Form – MRR Efforts and Records form would create a better user experience by having separate forms for teams focused on different fish species, as those working on salmon used fewer of the form fields than those working on suckers. We could have developed a more streamlined version of the form for those working on salmon species.

Electronic Field Devices

Two types of tablets were tested for field use, an Android Samsung Galaxy TabActive4 Pro and an iOS iPad.

The Samsung Galaxy TabActive4 Pro (Android) includes a 10.1-inch display, 128GB storage, 6GB RAM, and Wi-Fi + LTE capability. Its rugged design performed well in field conditions and supported Bluetooth integration tools easily.

The 10.9-inch iPad (Wi-Fi + Cellular, 256GB) provides reliable performance. The cellular model was necessary because it includes a built-in GPS/GNSS receiver; Wi-Fi-only models do not include GPS and are not suitable for field location data collection. iPads were not found to be a preferred option as they did not support Bluetooth connectivity with the PIT Tag reader or scales. iPads are also known for overheating and shutting down when exposure to hot weather while in a field vehicle or during field use which makes them less suitable for this type of work. However, some of the KBFC members work for organizations that require the use of iPads.

In addition to the tablets themselves, it is also important to prepare for long field days that may outlast a single charge of the tablet's battery or other issues that may render the tablet unusable. To ensure uninterrupted field data collection, car chargers and battery packs were included, as well as back up tablets. Given the potential extreme field work environment, it is important to plan how to use the tablets during cold or very sunny and hot days. A stylus will improve using the screen interface as cold fingers or wearing gloves can make it harder for the screen to detect the touch. As stylus are easily lost when dropped out in the field, tying the stylus to the tablet is recommended. For very sunny days, it may be difficult to view the tablet's screen without having a shady area to work under. For hot days, it is important to remember not to leave the tablets in a vehicle or directly exposure to the sun where overheating can occur causing the iPad to shut down.

Bluetooth Integration

Bluetooth was used to support automated data capture, particularly for PIT tag numbers whose long character count can easily result in errors when typed or written down manually on a form.

SerialMagic Keys Pro was the software we tested to integrate Bluetooth in our data flow. This software was required to pair PIT tag readers to the tablets to send data from the PIT Tag reader directly into Survey123 fields. This allowed PIT tag numbers to be entered automatically by selecting the field on the Survey123 form and then scanning the PIT tag. Currently, this software can

only be used on Android tablets. This software is not compatible with iPads, and no equivalent solution was identified for iOS devices.

PIT Tag Readers

Performance varied between PIT Tag reader devices that we tested. The Biomark HPR Plus, Biomark HPR Lite, and the BPR3001 handheld PIT Tag readers were tested during this project. We found that the older HPR Lite handheld PIT Tag reader had a specified time interval at which they would turn off, losing the Bluetooth connection. The older HPR Lite model we tested tended to break the Bluetooth connection if not actively in use after 5-minutes which resulted in user frustration when working in the field. The newer BPR3001 handheld PIT Tag reader performed better and was easier to connect. Successful setup to autofill PIT tag numbers into the Survey 123 form required pairing the reader to the SerialMagic Keys that is installed on the tablet. Once the PIT Tag Reader is connected to SerialMagic Keys Pro, open the Survey123 form, click the field in which the PIT Tag number should be populated, and scan the PIT Tag (Figure 2).

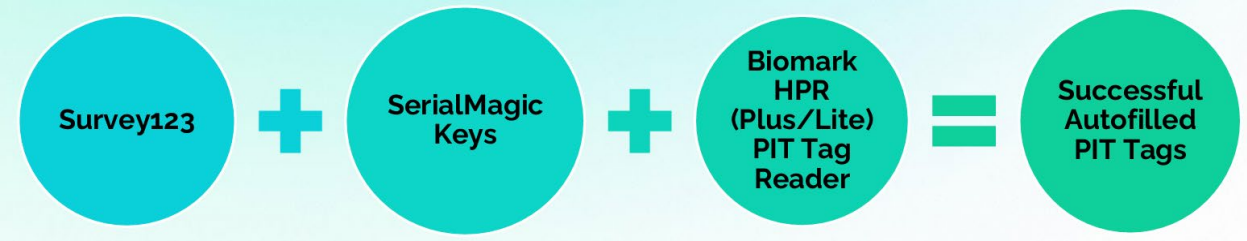

Figure 2: Technology combination for successful electronic autofill PIT tag numbers into the Survey123 form field.

If this step was skipped, connection issues occurred. For instructions on how to set up pairing https://www.kbfishc.org/serialmagickeys_sop_updated_20260203/ (if this document link becomes outdated you can locate current versions on the document resources section of the https://www.kbfishc.org/ . This document also includes information about troubleshooting.

As of June 2026, the SerialMagic Keys application software was not compatible to connect iOS iPads to PIT Tag readers.

Fish Scales

Two Bluetooth-enabled scales were tested, the Ohaus Scout SPX6201 and the A&D SJ-3000WP-BTF.

The Ohaus Scout SPX6201 (with Bluetooth interface, SKU 30268985) is a light scale that weighs 2.2 lbs. (1 kg) making it practical for field work. It provides accurate measurements with a capacity of 6,200 g (13.6 lbs.) and readability to 0.1 g. It uses AA batteries and transmits weight electronically when the “print” button is pressed. However, the Bluetooth interface remained available from European vendors, but it has been discontinued in North America. The Bluetooth interface software was discovered to have been last updated in 2017 and was too old to be compatible with newer tablets. Thus, we were not successful in capturing weights on the Survey 123 form using this scale.

The A&D SJ-3000WP-BTF scale includes Bluetooth connectivity, an IP67 rating for water and dust protection, and high-resolution measurement capability. It has a capacity of 3 kg (6.6 lbs) and weighs approximately 4 kg (9 lbs.), which would make it less attractive for field work requiring hiking a distance from the vehicle. The scale was not intuitive in terms of how to connect it using the SerialMagic Keys Pro software. The software vendor was contacted for guidance, but a solution was not received by the time this version of the Lessons Learned document was produced.

In both cases, Bluetooth integration with Survey123 to capture weights using portable scales was more challenging than expected. Bluetooth technology to capture weights on electronic forms is used successfully on larger scales, but these aren't appropriate for field work. Merck Animal Health vendor has identified another potential portable scale with Bluetooth functionality, but this scale was not available for purchase and testing during the project's performance period.

Data Flow and Automation

Scripts and automated processes were developed to move data from ESRI environments to local databases and to connect with the KBFC API to submit data into the KBFC database. Automation improved efficiency but did not replace the need for data review. Users must still plan to verify records and correct errors manually, either on the ESRI Cloud or on their local database. To ensure that data are edited at the appropriate stage of the data exchange process and that corrections are not overwritten, additional training was needed on when to edit records in ESRI Cloud and how to manage data once it has been pulled into local systems.

When using ESRI for data automation from field survey 123 forms to the organization, it can be beneficial to also develop ESRI data dashboards for the users. Users find these easy to use to confirm data submissions, which assists in developing trust with the new data flow, and to facilitate review of data. If these data dashboards can be further developed to support supervisors' assessments and reporting needs, this added benefit associated with electronic data flow can further assist with adoption of the new data workflow.

A zip folder containing database schema and custom scripts developed to flow data from ESRI cloud to local database, and to connect to the KBFC database is available on the KBFC website: KBFC Database - Klamath Basin Fisheries Collaborative. Additional resources related to SerialMagic, Survey 123 forms, KBFC Data Entry Guide, KBFC Data Uploading Templates, KBFC Controlled Vocabulary and Data Exchange Standards, KBFC Data Sharing Agreement, and Python Data conversion kits for legacy data are also available from this site.

Training and Organizational Adoption

Training is necessary to support adoption of new workflows and tools. Clear guidance is needed for device setup, form use, Bluetooth pairing, and data editing. Timely responses to user questions, troubleshooting assistance, and short refresher sessions are important to avoid user frustration and potential abandonment of the new data flow process. Providing ongoing support is critical to maintain adoption, especially when the user may be sporadic in using the tablets and electronic data flow due to the sporadic nature of that portion of their field work.

For the KBFC data modernization project, training was provided through MS Teams and in-person sessions. Additional training resources were provided by developing user instruction

documentation, including the standard operating procedures (SOP) document developed for using SerialMagic software. To be more responsive to user questions and requests for support, two additional staff were assigned to review existing documentation and respond to support requests.

Early involvement of field staff in testing and development helped ensure that tools match operational needs. Additionally, the success of permanent adoption is improved if specific individuals within organizations serve as points of contact for both the developing team and colleagues within their organization. These individuals can help their colleagues, communicate issues to the developers, and bridge the connection between developers and those learning the new workflow.

Key Lessons Learned

- Identify field staff who will be available to inform development and for user testing.
- Identify champions within organizations who can facilitate adoption and provide support to their colleagues.
- Clearly communicate expectations during pilot testing to improve feedback.
- Define data requirements and validation rules before developing forms and databases; align Survey123, local databases, and API requirements early, and to ensure interoperability assign the same team to develop the three components.
- Consider how separate forms can be used to keep forms simple and aligned with workflows. For example, different forms for different species may improve efficiency when teams only work on a subset of species.
- Keep electronic data forms simple and consistent with existing field practices, aiming to replicate paper forms as closely as possible.
- Use tablets that meet field requirements, such as selecting iPads with GPS capability.
- Plan for challenges with Bluetooth device integration and for the software and hardware upgrades needed to maintain compatibility between Bluetooth devices and tablets, including the use of newer PIT tag readers for more reliable performance.
- Test full data workflows together, not just individual components in isolation.
- Develop clear documentation including documentation for setup procedures, FAQs, troubleshooting checklists, and data editing guidance to prevent accidental overwriting when uploading or downloading data.
- Provide training and ongoing support.
- Create data dashboards or similar data visualization tools to facilitate review and to provide additional value to adopting the modernized data flow process.

Conclusion and Recommendations

The KBFC data modernization project provided valuable insight into the challenges and opportunities associated with implementing an electronic field data capture and data exchange workflow across multiple organizations. While the project successfully demonstrated that Survey123, cloud-based data exchange, APIs, and Bluetooth-enabled devices can support the collection and sharing of KBFC data, the effort also highlighted several considerations that should be addressed by organizations implementing similar workflows.

One of the most important lessons learned is the value of involving field staff throughout development and testing. Staff who regularly participated in testing provided practical feedback that improved the Survey123 forms, field workflows, hardware selection, and data exchange processes. Observing users interact with the technology under actual field conditions helped identify issues that would not have been apparent during office-based testing. In addition to improving the technology, involving staff throughout development helped build familiarity with the new workflow and created knowledgeable users within participating organizations. These individuals often became important resources during implementation, assisting colleagues with adoption, troubleshooting, and communicating improvement opportunities back to the development team.

Future projects should also plan to test the entire data flow process rather than individual components in isolation. Moving data through the complete workflow, from field collection through cloud storage, local databases, and final data submission, provides the opportunity to identify issues with validation rules, data formatting, and interoperability before deployment. End-to-end testing can reduce the risk of discovering problems later in implementation when changes become more difficult and costly to address.

When developing electronic forms, organizations should invest time in understanding existing field workflows before designing the forms. Forms that closely mirror established paper datasheets are generally easier for staff to adopt because they align with field practices that have already been refined over time. Observing users working in actual field conditions is particularly valuable for identifying opportunities to improve form layout, navigation, and usability. Where field programs differ substantially, separate forms may provide a more efficient solution than a single form designed to meet all possible use cases.

Projects should also ensure that data requirements and validation rules are clearly defined before development begins. Regular coordination between staff developing electronic forms, databases, and APIs can help prevent inconsistencies and reduce the need for later revisions. Where possible, having the same team develop these components can further improve interoperability and reduce misinterpretation of data requirements.

Hardware and software selection should be evaluated based on field requirements and integration needs. Compatibility between tablets, Bluetooth devices, and supporting software should be verified before deployment. Organizations should also plan for future software and hardware updates to maintain compatibility over time. Testing conducted during this project demonstrated that newer PIT tag readers generally provided more reliable Bluetooth performance than older devices, while tablet selection should consider factors such as GPS capability, operating conditions, and support for required peripherals.

Training and user support should be planned as ongoing activities rather than one-time events. Clear documentation, setup procedures, troubleshooting guidance, and refresher training can help maintain user confidence and reduce frustration. This is particularly important when users only interact with technology during specific field seasons or activities. Identifying individuals within participating organizations who can serve as local points of contact can further support long-term adoption by providing assistance to colleagues and facilitating communication with developers.

Finally, organizations implementing electronic field data collection should consider developing dashboards and other data review tools in addition to the core data flow. These tools can help users verify submissions, review data quality, and support reporting needs. Providing immediate value to users beyond data entry can help build confidence in the new workflow and encourage long-term adoption.

Overall, the project demonstrated that successful implementation of an electronic data capture and data exchange workflow requires attention not only to the technology itself, but also to user engagement, testing, training, workflow design, and organizational support. Addressing these considerations early in a project can improve implementation efficiency and increase the likelihood of sustained adoption.

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