Interagency Ecological Program
Fish Data Quality Control Best Practices

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Interagency Ecological Program
for the
San Francisco Bay-Delta Estuary

A Cooperative Program of:

California Department of Fish and Wildlife

California Department of Water Resources

National Marine Fisheries Service US

State Water Resources Control Board

US Army Corps of Engineers

US Bureau of Reclamation

US Environmental Protection Agency

US Fish and Wildlife Service

US Geological Survey

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Figure 1 DWR's Aquatic Ecology Program Beach Seining in the Toe Drain

Acronyms & Abbreviations

CDFW – California Department of Fish and Wildlife
CNRA-California Natural Resources Agency
CPUE- Catch Per Unit Effort
DUWG- Data Utilization Work Group
DWR – California Department of Water Resources
EC- Electric Conductivity
EDI-Environmental Data Initiative
GIS-Geographic Information System
ID- Identification
IEP- Interagency Ecological Program
N/A- Not applicable
PST-Pacific Standard Time
QA- Quality Assurance
QC-Quality Control
SME- Subject Matter Expert(s)
SOP- Standard Operating Procedure(s)
USBR- United States Bureau of Reclamation
USFWS- United States Fish and Wildlife Service

Scope and Application

This best-practices document outlines general considerations and recommended procedures applicable to data review and quality control of fish data. This document applies to any IEP agencies and programs involved in the collection and review of fish data. The scope of this document is limited to data review and quality control (QC) of fish measurement, identification (ID), sexing, staging, and associated data (such as location, water-quality parameters, flow data, and frequency of data collection). This document will not address field methods guidance and is limited to methods from the data recording stage to the reporting stage.

This document is designed to provide guidance and recommendations to staff involved or managing fish-monitoring projects and programs in how to record and review fish data for QC purposes. The appendices are intended to be used as resources for collection of field data. The recommendations and resources in this document are meant to picked and chosen from; it is not intended that every recommendation, code, or data field be used. They are intended to be reviewed and evaluated if they are applicable to the study or monitoring effort. Appendix I includes various standardized codes that can be used in the data-recording process. Appendix II is a checklist of all the various data fields that are recommended to be considered when a fish-monitoring program is determining pertinent data collected for a program. Appendix III includes template datasheets that may be used for a fish-monitoring program, either for adult/juvenile fish collection or larval fish collection. The checklist from Appendix II is a companion to the templates to help users ensure they have included all the pertinent data

fields for their project. Appendix IV includes examples of filled-out datasheets using the templates for reference.

Background

The purpose of this document is to provide guidance to project leads and staff in developing robust data review and QC procedures. By following this guidance, the IEP will establish a consistent approach for data entry and review of fish data and associated data. The elements outlined in this document are intended to be used in developing fish data review and QC standard procedures for the projects and programs within the IEP that collect applicable data.

Consistent and robust procedures in data collection and review are of fundamental importance because they support development of data-driven management decisions. Following consistent and well-documented procedures supports the IEP's fundamental principles of providing high-quality data collected with integrity.

Personnel Recommendations

Fish Identification Training

Staff should take a fish identification class, offered by a university, State or Federal agency, or other qualified instructor for California freshwater, marine, and anadromous fishes if they are involved in fish ID. See Appendix I for a list of common and scientific names of species found in the San Francisco Bay-Delta. Appendix I also includes a link to photographs of select species in the South Delta. Staff should familiarize themselves with technical documents regarding identification among life stages of fish (e.g., McGinnis 2006, Miller and Lea 2020, Moyle 2002, Wang 2007, Wang 2011, Wang and Reyes 2007, and Wang and Reyes 2008.)

Fish Handling Training

Prior to working with fish, staff should review *Guidelines for the Use of Fishes in Research* published by the American Fisheries Society (AFS) and understand what State, and possibly Federal, permitting will be needed for take, collection, handling, possession, transfer, storage, and disposition of samples of whole fish or parts thereof.

Voucher Collection

Fish sampling efforts could consider creating a collection of representative specimens, photo library, or both for validation of naming conventions and aiding in fish identification. Methods and techniques for fish preservation and how to document samples can be found in AFS publications Fisheries Techniques 3rd ed. and Methods of Fish Biology, as well as various published articles. Ichthyology collections operated by UC Davis museum of wildlife and fish biology (https://mwfb.ucdavis.edu/fish-collection), California Academy of Sciences (https://www.calacademy.org/scientists/ichthyology), and Natural History Museum of Los Angeles County (https://nhm.org/research-collections/departments-and-

programs/ichthyology) could also inform voucher collection methods. Voucher specimens should be kept separate from those used for training (e.g., counting myomeres, fin rays), as handling specimens tends to damage them. Photo libraries of Delta fishes are available by USBR Photo Gallery of Fish of the South Delta (https://www.usbr.gov/mp/TFFIP/photo-gallery-fish-south-delta.html) which could be used by studies as a direct reference and also a model for how to create a voucher for life stages relative to the sampling activity. Photos and voucher specimen locations for nonindigenous species are available from USGS NAS (https://nas.er.usgs.gov/).

Data Entry & Editing

New staff should be trained by subject matter experts (SME) and/or crew leads in proper data recording, entry, and review procedures. Data entered by new staff should undergo more thorough QC by crew leads and other more experienced staff until they are fully trained and comfortable performing the tasks with less oversight. All data entry must be QC'ed by staff other than the staff that entered the data unless alternate staff are not available. If possible, the QC staff should be a field crew member who has historical experience in the environment and may be better able to gauge erroneous data entry.

SOP training

All staff are required to be trained to follow their program's Standard Operating Procedure (SOP) and all safety protocols prior to commencing work. Staff should regularly hold crew meetings to review and clarify their SOP. A training checklist should be used to track new staff's training progress and ensure all staff are proficient before performing work without a trainer.

*****Note: It is highly recommended that all training and proficiency be documented.

Recording Data

The following best practices are a combination of both recommendations and general requirements regarding fish data entry. These practices will aid in the development of standard operating procedures and support consistency among programs collecting fish data in the IEP.

Data Sheet Sections

An acceptable data sheet is clear, legible, and contains all the information needed to accurately interpret the data. See Appendix I for example codes that correspond to the below subsections.

1. Data Sheets:

Use "all weather paper" suitable for copiers and printers (e.g., Rite-in-the-Rain®) to print paper data sheets. It is highly recommended to use waterproof, permanent ink such as Rite in the Rain® pens where feasible. If not feasible, pencil may be used. Pen should always be used in dry conditions.

2. Data Sheet Instructions:

Make the data sheet easily understood for staff entering data. Include instructions as needed and include lists of standardized codes and abbreviation descriptions on the data sheet or data binder, as well as listed in the project metadata.

3. Sample Collection Information:

Record sample event date, time, location/station, sampling gear, relevant sampling effort parameters, and the names of all crew members. Identify the name of the person that is recording the data. If relevant, also include the names of vessel(s) and boat operator(s).

4. Quality Control:

Include a variable or code that indicates the quality of the sample to differentiate between "normal" samples, samples that could not be taken, and samples that were taken but impacted by environmental conditions, debris, human error, etc. Also include a note in the comments to describe any abnormality in sample collection.

5. Environment and Habitat:

Record information on weather, tide, substrate, habitat, or other parameters of interest.

6. Water Quality:

Record water-quality parameters and the measurement equipment used. The data sheet should indicate the precision required. If readings were not taken, put a line through these boxes and provide justification, initial, and date with footnote numbering within the comment section. If the readings are suspect, indicate within comments and if there were any measures taken. This could include re-measurement or troubleshooting with the equipment.

7. Fish Data:

Record fish species name or code and lengths, define if total length, fork length, or standard length and the unit used (e.g., millimeter, centimeter, etc.). Some organisms are measured as width, not length (e.g., Bay Ray, crabs). Record total catch, with any additional plus count for fish that were not measured. Indicate if no fish were caught in a sample (write "no catch"). The data sheet should specify at what number of individuals plus counting starts, and it may be different for different taxa (i.e. native vs nonnative). If individual fish need to be tracked, include unique fish identifier on your data sheet and any other relevant data sheets to ensure they can be connected and reported efficiently. Indicate whether any mortalities were encountered and if any fish were saved. Record if any tissue samples, fin clips, or scales were collected, including the disposition of the fish, and identifying code for tracking the collected samples. Record weight, life stage, and other special information as

relevant to your program and species. Refer to IEP's recommended fish codes and parameter list for naming convention guidance (Appendix 1- fish ID codes).

8. Comments:

The comments section should be used to note variations in the procedures, and notable field conditions. Appropriate comments can be crucial in resolving questions about the data that arise later. If you have troubleshooted a suspicious value and resolved the issue, also document it in the comment section. Note if photos are taken of any fish for later ID verification purposes.

Data Sheet Best Practices

The clarity and usability of a data sheet can be enhanced by keeping the following in mind:

1. Legibility:

While electronic data sheets are preferred, legible handwriting is a **must** for hand-written data sheets**.** If a measurement is illegible, the effort taken to obtain the measurement is wasted. It is highly recommended to use waterproof, permanent ink such as Rite in the Rain® pens where feasible. If not feasible, then pencils may be used. Pen should always be used in dry conditions.

2. Clarity:

When filling out a data sheet, ensure all information is clear enough so someone who is not familiar with past conditions can interpret the data accurately (i.e., no slang, abbreviations, or omitted data).

3. No Data and Zeroes:

If data are not recorded for a relevant parameter, put one line through the appropriate box and write an explanation why the data were not taken in the comments section. If no fish were caught, indicate with a code or description that a sample was taken, but no fish were caught. It is important to notate this distinction, as zero catch data are used in effort calculations, while a non-sampling event would not be used in effort calculations. Note: if using electronic datasheets, enter "N/A" in the data field if permitted by the database, or otherwise leave blank. In either case, make a note of it in the comments section. If choosing a different term, be sure to use the term consistently in the database.

4. Comments:

Comments should be written so that they are specific and are easily understood. Use the comment field to document any unusual situations or changes to the SOP.

5. Corrections:

Corrections to a data sheet made in the field should be lined out with one line, initialed and dated by the individual making the correction.

6. Organization:

Organize the data sheet so that measurements from one species are recorded together. If this isn't possible, draw an arrow, make a note, and initial with date to show continuation of a species within the same sample if using a paper form. If multiple data sheets are used for a sampling event, label page numbers and draw an arrow and make a note to indicate continuation from a previous page.

7. Disagreements:

Determine as a program how to resolve disagreements or uncertainty in fish identification. Use field guides and send photos or bring fish back to experts for identification (if allowed by permits). Record any counts or measurements. Notate uncertainty on the data sheet, and once identified, modify species code on data sheet with initials and date.

8. Estimated information:

It is not recommended to estimate information, but in special cases it may be useful. A few examples are: estimating fork length of Delta Smelt since they can't be handled, estimating depth in shallow waters, estimate the last digit for water quality readings if the sensor is fluctuating. If any estimated data is collected, it needs to be clearly documented in the comments.

9. Photographs:

It is recommended to take photographs of wet field sheets.

Summary Sheets (Optional)

The purpose of the summary sheet is two-fold: (1) it provides an independent, quick way to check total species counts in the database, and (2) it gives the field crew an opportunity to check their data sheets critically at the end of the day. Summary sheets should be filled out completely and carefully using the following procedures:

1. Fill out one summary sheet per day for each gear type used (beach seine, Kodiak trawl, midwater trawl, fyke nets, etc.). If using more than one summary sheet, write down a page number and total number of pages (e.g., "2 of 5") at the top of the page.
2. The location should be entered for each site on the run in the order they were visited. If trawling, record the location name followed by tow number in ascending order.
3. If a site was not sampled, indicate on the datasheet that the site was not sampled, but enter as "0" if no fish were caught at the site. Enter the total (measured and plus

counts) number of fish of each species caught for each location or tow. Use additional sheets as necessary and number them (e.g., “2 of 5”).

4. Record the total daily catch for each species.
5. Transfer any pertinent comments from the field sheets to the summary sheet. These comments would include unusual conditions that would affect the fish catch (such as vegetation blocking, construction preventing access, high debris load), or reasons why a site was not sampled or a tow was not conducted, etc.
6. Identify the name of the person who filled out the summary sheet.
7. Summary sheets should be checked by a second person on the field crew that day.

Database Data Entry Best Practices

1. Data sheets should be scanned to make an electronic copy at end of each field day or soon after collection to ensure a backup is available. When appropriate, photos of the data sheets may be taken before they are scanned. A “final” scanned copy of the data sheet could be necessary following any changes or corrections to data sheets, such as following confirmation of fish identification in a laboratory. Keep original data sheets in office and in a safe and secure location until electronic backup is completed. Electronic or paper copies should be provided to staff doing remote data entry.
2. Data should be entered into database as soon as reasonably possible upon returning from the field. Ideally within a week or following completion of sampling.
3. If data are missing for a field on the field data sheet enter N/A in the data field. Programs should be consistent in their approach for recording start and end values (e.g., flowmeter counts) when missing a value. For example, if missing a start flowmeter value, you could enter the value of “N/A” and the actual end meter or you could enter both as N/A on the data entry screen. Your approach will be informed for how you contend with missing data, especially from a calculated field (e.g., end flowmeter count – start flowmeter count = total counts).
4. Leading zeros do not need to be typed in any of the numeric fields, providing that a decimal point is used where appropriate.
5. If there is a comment on the field data sheet, type it into the comment data field on the data entry screen. The only exception is if the comment is not relevant to the study, such as a comment that relates to a different study at the same site.
6. *Catch detail*. For ease in QC, enter fish data, notably fish length values, in the data entry screen in exactly the same order as it appears on the field data sheets, with the exception of plus counts. It is recommended to enter plus counts last.

Quality Control

Field Data sheet checks

During fish identification (ID), a secondary crew member should confirm the ID, if possible, given time constraints. If time constraint is an issue, secondary ID should be reserved for double-checking less experienced staff, and when there is any doubt about the correct identification of the species. If any staff have doubts on the confidence of a fish ID, follow protocols to take photos, consult staff at the office, or save the fish, as appropriate. Once the field data sheets are completed, they should be checked by someone (other than the data recorder) who is trained on the process prior to leaving each field site. These checks should include, but are not limited to:

1. Missing data (blanks on the data sheet)
2. Illegible entries
3. Plus counts not calculated or recorded
4. Incorrect species codes
5. Incorrect station codes
6. Data entered in the wrong place
7. Addition or transfer errors on the summary sheet
8. Inconsistencies (time, meter and/or gear serial numbers, temperature)
9. Sample bias (if fish lengths have a pattern such as decreasing, it can indicate that the fish subsampled from large catches were not chosen at random)
10. Flow meter readings copied incorrectly from one tow to the next
11. EC meter units not defined

After checking the data sheets for the errors, organize them in chronological order with summary sheet on top (if using) for secure transport back to the office, and deliver to the office staff who will be re-checking the datasheets prior to entry into the database. Upon delivery to the office, all paper datasheets should be scanned or photographed. Document any errors found in the datasheets. Errors are noted with initial and date.

If time and staffing constraints allow, “real time” data QC checks may be done. For these QC checks, crew members conduct real time data entry each day or following day from datasheet photos or scanned data sheets that are uploaded to a shared online location. It is highly recommended that these staff be experienced staff. Crew performing “real time” entry should immediately report any abnormalities to field crew leads or supervisors. During larval fish season, data are entered as soon as larval ID is completed, unless the larval ID is completed by contract. In this case, data must be entered as soon as the larval ID data is received from the contractor. Crew entering data should ask field and lab crew about any questions while the data are still recent.

Data Entry checks

Data entry checks are critical to maintaining a high-quality dataset with minimal errors. Many of these checks can be performed with Microsoft Excel, Microsoft Access, GIS software (e.g., ArcGIS), and/or a programming language such as R. If data are collected using electronic datasheets, the process is simplified and involved directly uploading the data from the electronic datasheet to the database. For data collected on hard-copy datasheets, the data are first entered into database forms that should have customized error-checking and data validation checks (e.g., required fields that must be filled, number formatting rules). This helps ensure that simple entry errors are avoided. A second staff member compares the data in the database to original field sheets to ensure accuracy. Then, each data field is sorted and/or summarized based on unique records to highlight missing values and outliers for inspection.

Double-Data Entry

Another approach for ensuring data entry accuracy is double data entry. In this process, the same data are entered from the field sheets into the database twice. After double entering the data, compare the duplicate data entries. This step can be accomplished via Access queries or R code. Performing this step first will save time later by reducing the number of errors present during later QA/QC processes. This process follows the following steps:

1. Compare the tables from the 1st and 2nd entries.
2. If discrepancies are detected, consult the field data sheet to find the correct value.
3. If the field datasheet is wrong or unclear, it should also be corrected with a note or annotation, even in the copy in the digital archives. The incorrect data value should NOT be removed from the datasheet, but the correct value should be indicated via an annotation.
4. Additional QC checks can be done using an R script. From this, a list of errors can be generated in the station data and catch data that need to be corrected.

QC Following Data Entry

After data entry (single or double data entry), there are additional QC checks that should be completed before publishing data. These steps involve working in GIS software and R to check for outliers that were missed during data entry and editing. These steps should be taken before the dataset can be considered complete. This should be completed at least annually, and before the data are published.

1. Final runs of the R code or GIS software are completed to identify any discrepancies (such as missing start or end flow meter values), orphan records, etc.
2. Identify, investigate, fix, or flag any suspicious start and stop coordinates.
3. Outlier checking for water-quality values – generate lists of outlier values that should be investigated, fixed, or flagged as suspicious. R can be used to generate a list and scatter plots by region and date to aid in identifying outliers for investigation.

Check for outliers in fish catch data, ensuring that no odd fish detections are reported in the dataset that may be due to mis-writing species codes and were not caught earlier in the data review process. This step relies on a subject matter expert (SME). A query is run for the desired date range and output is shared with the SME. The SME highlights anything unusual or suspect and sends back the list. This list can be investigated by re-checking the datasheets. Corrections/flagging are done as needed.

QC Checks at differing timescales

Additionally, there are QC checks that can be done on a daily, weekly, and seasonal, and annual time frame. It is strongly recommended to conduct QC checks on data monthly, at a minimum. Daily quality control may use code (such as R or Python) database queries, or another method to generate a daily report table (pulling data entered into the primary database). After the code or query is run, the resulting data table should be compared to field data sheets to find any issues that may have arisen during data recording or entry. The focus of this basic QC is on accessory information (e.g., station code, coordinates, water quality values, categorical parameters) and species catch info.

Weekly or monthly QC may use coded data checks to identify any issues/suspicious values that should be addressed before the weekly report is generated. The code checks can include checks of any data fields collected, such as sample site info (stratum, site name, coordinates, date), volumes, and condition code. Catch details are also checked for all Delta Smelt records. Code can also be used to find outliers. Multiple exports can be merged (fish, zooplankton, sites) for further analysis. Scatterplots, line charts, histograms and boxplots are used to see if there are any anomalies, or if the data seem unreasonable compared to historical ranges. Volumes are also checked to make sure they're reasonable. Then the fish data and CPUE (by species) are paired with it. After water quality has been QC'd, it is flagged and paired with the biological data. As the process is moved through, the number of samples is double checked to ensure that none were lost/added through each step.

The data may also be analyzed using code or query by season or year. Histograms and boxplots can be used for each species for lengths and CPUE. Double checks are done to make sure the total numbers of measured individuals and total numbers of species come to the correct total. Be sure that it is clear what lengths are being measured (fork length, standard length, or total length).

Data QC notes

It is very important to identify in data documentation the uncertainties involved in data collection. For example, species <30 mm may not be reliably identified to species (such as in minnows, basses, and lamprey).

Data Analysis & Calculations

Below are common calculations that are used in the analysis of fish data that may be helpful to consider. Additionally, please reference American Fisheries Society fisheries Techniques, 3rd edition, for additional sampling gear descriptions and equations.

- If calculating volumes from flowmeter counts in towed nets, it is important to document the brand, model and conversion factors used in conversions. Flowmeter counts are often converted to distance (e.g., meters) that are multiplied by mouth area of nets (e.g., m^2) which results in cubic meters. For example, General Oceanics flowmeters use the following (ENVCO 2022):

4. Calculations

10 counts are equal to 1 rotor revolution on the graphic labels on all flowmeters. The cts/sec. Is "counts per second" and must not be used as revolutions per second for calculations.

ROTOR CONSTANTS: Standard Speed Rotor Constant = 26,873
Low Speed Rotor Constant R6 = 57,560
(R2) Low Speed Rotor Constant = 51,020
Speed Curve See Page 11

A. DISTANCE in meters = $\frac{\text{Difference in COUNTS (X) Rotor Constant}}{999999}$

(Example: Where the graph may indicate 100 cts/sec this is also equal to 10 revolutions/sec). Therefore please ensure the correct units are being used when measuring and calculating.

B. SPEED in cm/sec = $\frac{\text{Distance in meters (X) 100}}{\text{Time in seconds}}$

C. VOLUME cubic meters = $\frac{3.14 \text{ (X) (Net Diameter)}^2 \text{ (X) Distance}}{4}$

- Cable out and cable angles to determine depth of gear.

- Catch Per Unit Effort (CPUE) is used for multiple kinds of biological data and with various gear types. The calculation may vary depending on Gear type.

  For beach seine data, CPUE is also referred to as Catch Per Volume (CPV). The calculation is as follows:

  CPUE = Count/Volume

  Volume = length * width * height
  Note: height is calculated by averaging the water height at each end of the beach seine net.

  For rotary screw trap and fyke trap sampling, the calculation is:

  CPUE = Count/hours fished

For larval fish sampling, the calculation is:

CPUE = ($\frac{FlowmeteDifference * FlowmeterRotorConstant}{999999}$)/Net Volume

- Beach seine volume= (Net length * Net width * Net depth)/2

- Otter trawl volume = [(NetMeterEnd)-(NetMeterStart)*0.02687*2.75m^2]
    - (0.02687)= K factor (General Oceanics Flowmeter 2030)
    - 2.75m^2 = estimated net mouth area

Also see Otter Trawl Mouth Area and Lampara Volume Calculation documents in the References section.

Record keeping/Archiving

Hard-copy field sheets generated by staff and received from contractors (such as outside lab data) are stored, and electronic copies are archived on network drives, with accessibility and long-term storage in mind. Original data sheet copies should be retained for a minimum of 5 years (IEP Archiving Guidelines, 2010). Correction logs with data entry history should be included with paper and electronic copies.

Consistent file naming conventions within a program should be used for electronic copies of datasheets for ease of access.

A Data Management Plan (DMP) should be created to document how the data is being managed. This should include information about where the data is backed up, and frequencies of backing up and archiving. A template for DMPs is available on the DUWG page of the IEP website (https://iep.ca.gov/Data/Data-Utilization-Working-Group).

Data Reporting

Include information on data reporting processes, both internal and external. If there are requirements for how frequently the data need to be reported, document those. For compliance with AB1755, include information on process and frequency of posting to CNRA Open Data portal (https://data.cnra.ca.gov/). If you are posting your data to the Environmental Data Initiative (EDI) (https://edirepository.org/) , document the appropriate references for connecting the EDI datasets to the CNRA Open Data portal which are available through the DUWG Github (https://github.com/InteragencyEcologicalProgram/Open-Data-and-Data-Publishing/blob/master/Resources/Connecting%20EDI%20to%20CNRA_20200626.docx).

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Revision History

Revision	Effective Date	Section	Description of Change	Justification of Change
1.0	5/1/2023	All	New document	Creation of new document

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Appendix I- Data Sheet Codes

Interagency Fish Identification Code.
https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=197029&inline

Nelson, J.S., Crossman, E.J., Espinosa-Pérez, H., Findley, L.T., Gilbert, C.R., Lea, R.N. and Williams, J.D., 2004. Common and scientific names of fishes from the United States, Canada and Mexico. American Fisheries Society. https://doi.org/10.47886/9781934874318

United States Bureau of Reclamation. Photo Gallery – Select Fish of the South Delta.
https://www.usbr.gov/mp/TFFIP/photo-gallery-fish-south-delta.html

Table 1 Example of Gear Condition Codes

Gear Condition Code	Description	Notes
1	Good, normal	
2	Fair, sample partially compromised	-CPUE can still be calculated with confidence -Less than 50% loss in effort or catch -small stick in seine, branch in trap but still spinning, twisted seine bag, significant debris in cone
3	Poor (sample majorly compromised)	-CPUE not accurate -Only recorded for reporting purposes -Big log or debris in seine, preventing seine from being fully on the bottom, branch in trap stopping it from spinning -50%+ loss in effort or catch
4	No sample taken	-Attempted to sample, but site not accessible, or unable to finish

Table 2 Example of Weather Codes

Weather Codes	Description
CLR	Clear
RAN	Precipitation
CLD	Overcast at time of sampling
FOG	Foggy
NIT	Night

Table 3 Example Wind and Wave Codes

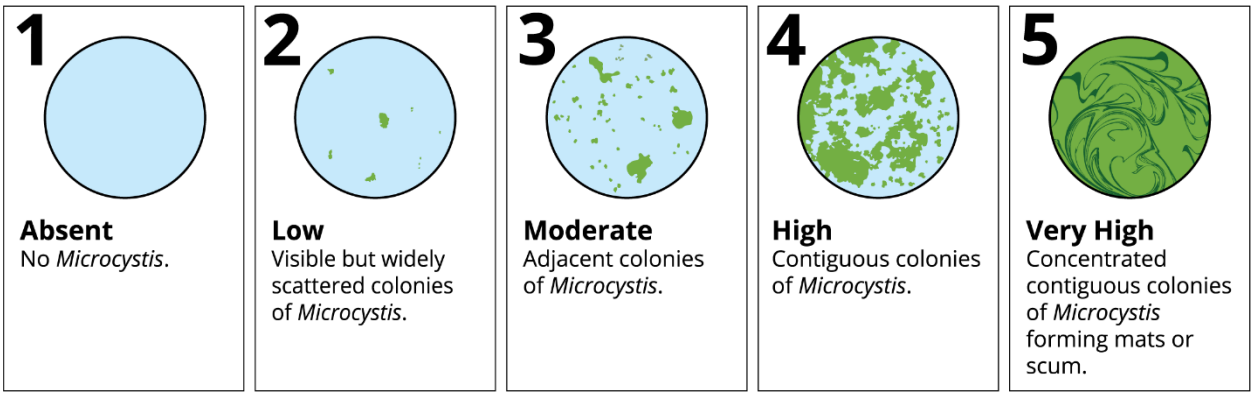
Wind and Wave Code	Description
Low	Still to light breeze,
Medium	Strong breeze to mildly windy (approx. 10-20 mph), some whitecaps
High	Very windy (approx. 20mph+), choppy water
Wind direction	(N, S, E, W, SW, SE, NE, NW, or NA (no wind))

Table 4 Example Tide Codes

Tide Codes	Description
HIS	High Slack
Ebb	EBB Tide
LOS	Low Slack
FLD	Flood

*Note this is specific to the site you are sampling, tides may vary between large channels and wetlands.

Figure 2 Example Microcystis Indices



10.6084/m9.figshare.19239882.v1

Table 5 Example Substrate Codes for Sweep Net

Substrate Codes	**Description**
EAV	emergent aquatic vegetation
FAV	floating aquatic vegetation
SAV	submersed aquatic vegetation

Table 6 Example Substrate for Benthic Codes

Substrate Codes	Category	Particle diameter
CR	Coarse	>64mm
GR	Gravel	2-64 mm
SN	Sand	0.063-2mm
MD	Mud	Clay and silt, <0.063 mm
PV	Pavement	Uniform artificial concrete surface
VG	Vegetation	Vegetative matter

Table 7 Example Vegetation Code

Vegetation Code	Category
1	No vegetation present
2	Vegetation present, but no impact to sample: • Vegetation nearby; not in sample • Vegetation sample in small quantities, not affecting sample
3	Vegetation present and impact to sample: • Vegetation affecting sampling method (had to move) • Amount of vegetation in sample, affecting flowmeter or revolutions, fish health
4	Vegetation present and prevented sample for being taken

Table 8 Common Aquatic Vegetation of the Delta and Suisun Marsh

Abbreviation	Family	Genus	Species	Common name	Native/introduced	Growth form
ARUDON	Poaceae	*Adrundo*	*donax*	giant reed	Non-Native	emergent
AZOFIL	Salviniaceae	*Azolla*	*filiculoides*	water fern	Native	true floating
CERDEM	Ceratophyllaceae	*Ceratophyllum*	*demersum*	coontail	Non-Native	submerged
EGEDEN	Hydrocharitaceae	*Egeria*	*densa*	Brazilian waterweed	Non-Native	submerged
EICCRA	Pontederiaceae	*Echhornia*	*crassipes*	water hyacinth	Non-Native	true floating
FATHEN		*Atriplex*	*prostrata*	Fat hen	Non-Native	emergent
HYDRAN	Apiaceae	*Hydrocotyle*	*ranunculoides*	water pennywort	Native	rooted, floating leaves
LEMNA	Araceae	*Lemna*	*spp*	duckweed	Native	true floating
LILMAS	Apiaceae	*Lilaeopsis*	*masonii*	Mason's lilaeopsis	Native	emergent
LIMLAE	Hydrocharitaceae	*Limnobium*	*laevigatum*	spongeplant	Non-Native	true floating
LUDWIG	Onagraceae	*Ludwiggia*		water primrose	Non-Native	rooted, floating leaves
MYRSPI	Haloragaceae	*Myriophyllum*	*spicatum*	Eurasian water millfoil	Non-Native	submerged
PHRAUS	Poaceae	*Phragmites*	*australis*	common reed	Non-Native	emergent
POLAMP	Polygonaceae	*Polygonum*	*amphibium*	water smartweed	Native	rooted, floating leaves
POTCRI		*Potamogeton*	*cripsis*	curly-leaved pondweed	Non-Native	submerged
Abbreviation	Family	Genus	Species	Common name	Native/introduced	Growth form

SAGSAN	Alismataceae	*Sagittaria*	*sanfordii*	valley arrowhead	Native	rooted, floating leaves
SARPAC	Amaranthaceae	*Sarcocornia*	*pacifica*	perennial picklweed	Native	emergent
SCHACU	Cyperaceae	*Schoenoplectus*	*acutus*	hardstem bulrush	Native	emergent
SCHAME	Cyperaceae	*Schoenoplectus*	*americanus*	threesquare bulrush	Native	emergent
SCHCAL	Cyperaceae	*Schoenoplectus*	*californicus*	giant bulrush	Native	emergent
STUPEC	Potamogetonaceae	*Stuckenia*	*pectinata*	sago pondweed	Native	submerged
TYPANG	Typhaceae	*Typha*	*angustifolia*	narrow-leafed cattail	Non-Native	emergent
TYPDOM	Typhaceae	*Typha*	*domingensis*		Native	emergent
PLAT	Typhaceae	*Typha*	*latifolia*	broad-leaf cattail	Native	emergent

Appendix II- Data Sheet Checklist

Data Sheet Checklist

This checklist serves as a companion to the template data sheets for adult, juvenile, and larval fish data. The templates include all data fields that the DUWG QA Subcommittee defined as required, recommended, or as needed for data sheets. This checklist includes those fields as well as fields that may be appropriate or required based on the needs of your project. It is recommended to reference this checklist as a check ensuring that your project data sheets have fields for all the necessary information for your project.

Station Information:

Table 9 Checklist Part 1 Station Information

	Data Field	**Definition**	**Priority**
☐	Date	Date of sampling event	Required

☐	Time (PST, local time, military time)	Time of sampling event	Required
☐	GPS #	Number identifying specific GPS unit	As Needed
☐	GPS accuracy	Accuracy range of the GPS unit	As Needed
☐	GPS target	Target location of the sampling station	As Needed
☐	GPS start/end	Start/End locations, used during trawls	As Needed
☐	Location	General location such as region or water body	As Needed
☐	Station	Station name	Required
☐	Vessel	Identification of the vessel used for sampling event	As Needed
☐	Boat Operator	Name of staff who operated the boat/vessel	As Needed
☐	Weather	Description of weather conditions	Required
☐	Wind direction	Direction of wind	As Needed
☐	Waves	Description of condition of water surface	As Needed
☐	Tide	Direction of tide	Required
☐	Flow	Direction of flow in non-tidally influenced sites	As Needed
☐	Date of data entry	Date that data was entered into the data base	Required
☐	Data recorder	Name of the staff that entered the data into the database	Required
☐	Field Checker	Name of the person who checked the data sheets in the field	Required
☐	Field Crew	Name of all persons on the field crew during the sampling event	Required
☐	Comments	Additional comments noted during sampling	Required
☐	Paired Studies	If the sample effort is paired with another study, enter the code of the study it is paired with	As Needed

Water Quality

Table 10 Checklist Part 2 - Water Quality

	Data Field	Definition	Priority
☐	DO	Dissolved Oxygen (mg/L)	Required
☐	SPC	Specific Conductance (µS)	Required
☐	Temp	Temperature (^{o}C)	Required
☐	pH	pH	Required
☐	PC (phycocyanin)	Phycocyanin (RFU or mcg/L	As Needed
☐	Chl	Chlorophyll a	Recommended
☐	FDOM	Fluorescent Dissolved Organic Matter	As Needed
☐	Microcystis	Presence of Microcystis on water surface (scale of 1-5)	As Needed
☐	Turbidity	Turbidity (FNU, NTU optional) Required if Chl is collected	As Needed
☐	Vegetation code	Yolo Code of 1-4, based on how it affects the sample	As Needed
☐	Vegetation %	Percentage of coverage of vegetation	As Needed
☐	Secchi	Secchi depth (meters)	Required

Gear and Instruments

Table 11 Checklist Part 3 - Gear and Instruments

	Data Field	Definition	Priority
☐	YSI ID	Identification number/code or serial number	As Needed
☐	Turbidity ID	Turbidity instrument ID, if different from YSI	As Needed
☐	Gear type	Gear type used, such as seine or trap	Required
☐	Gear ID	Gear serial number	Required
☐	Condition Code	Condition of sample- (1 good, 2 fair, 3 compromised, 4 not taken, 9 net wings-fish not caught in the live box)	Required
☐	Net Deployment	Type of net deployment	As Needed
☐	Method	Method type for sample collection	Required

Trawl

Table 12 Checklist Part 4 - Trawl

	Data Field	Definition	Priority
☐	Flow meter serial number	Serial number of flow meter	Required
☐	Flow meter start/end	Start and end numbers from flow meter	Required

☐	Total rotations	Number of rotations between start and end of flow meter	Required
☐	Flow meter debris	Presence of debris in flow meter	Recommended
☐	Tow Number	Number of tows if they exceed 1	As Needed
☐	Max cable length	Length of cable to net	As Needed
☐	Flow Duration	Duration (in minutes) of the tow	Required
☐	Start Depth	Starting depth of the water column at the start of the tow	As Needed
☐	Flow Direction	Direction of the tow (upstream/downstream)	Recommended

Seine

Table 13 Checklist Part 5 - Seine

	Data Field	**Definition**	**Priority**
☐	Region	Region in which the seine was conducted	As Needed
☐	Length	Length of seine net (meters)	Required
☐	Width	Width of seine net (meters)	Required
☐	Depth	Depth of seine net (meters)	Required
☐	Disturbance	Description of disturbance at the site (any activity that would affect fish activity and therefore bias the sample)	Required
☐	Alternate site	List the site sampled if the intended site was not available due to disturbance or access	As needed
☐	Habitat	Description of habitat type (ex: riparian)	As needed
☐	Substrate category	Record the most abundant substrate type [coarse gravel (>6.4cm), gravel (2-64 cm), sand (0.062-1.99mm), mud (<0.062mm), pavement]	Required
☐	Water velocity meter	Identification code/serial number of meter	As Needed
☐	Water velocity meter depth	Depth as which the velocity meter was submerged	As Needed

Fish Count Data

Table 14 Checklist Part 6 - Fish Count Data

	Data Field	**Definition**	**Priority**
☐	Organism code	Code identifying species	Required
☐	Fork length	Length from nose to fork length (mm)	Required
☐	Weight	Weight (grams)	As Needed
☐	Fish Health Index	Condition of health of the fish	As Needed
☐	Count	Number of each species caught	Required

☐	Plus counts	Number of species not weighted and measured	Required
☐	Ad +/-	Adipose fin clipped (salmon/smelt only)	As Needed
☐	Genetics	Samples of tissue collected for genetics	As Needed
☐	Stage	Life stage of salmonid	As Needed
☐	Dead	Number of dead of each species of concern (circled on data sheet)	As Needed
☐	Expression (maturation)	Presence of milting for Delta Smelt, Wakasagi, Longfin Smelt, salmon	As Needed
☐	Eggs present on shrimp	Note of presence	As Needed
☐	Entered in Sample Inventory	Initials of the staff that entered the sample into the inventory	As Needed
☐	Datasheet scanned	Name of who scanned the data sheet	Recommended
☐	Data Entered By	Name of who entered the data in the database	Required
☐	Data QC'd by	Name of who checked errors between field sheet at database	Required

Juvenile/Larval Data

Table 15 Checklist Part 7 - Juvenile/Larval Data (Data collected in addition to what is listed with fish count data)

	Data Field	**Definition**	**Priority**
☐	# of jars/vials	Number of jar and vials will collected specimens	As Needed
☐	Jar type	Jar type- shape or volume	As Needed
☐	DSM Count	Count of juvenile Delta Smelt (lab only)	As Needed
☐	LFS Count	Count of juvenile Longfin Smelt (Lab only)	As Needed
☐	WAG Count	Count of juvenile Wakasagi (Lab only)	As Needed
☐	Box#	Box number that jars/vials are organized in	As Needed
☐	Yolk	Yolk status for QA\QC purposes [Absent (A), Present (P), Yellow (Y), Silver (S), no color (NC)]	As Needed
☐	Life Stage	Life stage for any species	As Needed
☐	Smelt BB	Smelt brachial basket [Unknown (U), Absent (A), Present (P)]	As Needed
☐	Smelt AB stage	Air Bladder status [Unknown (U), absent (A), present (P)/(Dip), air bladder bud (Bud), complete air bladder (AB)	As Needed
☐	Complete Air bladder	If present, describe in comments	As Needed

☐	PD	Pneumatic duct [Unknown (U), absent (A), present (P)]	
☐	Larval Fish ID by	Larval fish ID in lab	Required
☐	ID date	Date larval fish was ID'd in lab	As Needed
☐	Final ID	Final ID if there was a discrepancy in ID of larval fish	As Needed

Appendix III- Datasheet Templates and Examples

The templates linked below are intended as a guide for developing your own field sheets. Depending on your program, you may not require all the fields included in the template. It is recommended to refer to the checklist for completeness in creating your field sheets. This will help to ensure that you have all the fields needed for your field sheets.

The templates are color coded to identify importance of the data field, as defined by the DUWG QA Subcommittee that developed the templates. Yellow signifies required, Blue signifies recommended, and purple signifies as needed.

Examples using the templates are also included to provide more clarity on how the datasheets may be filled out. Notes are included in the examples as necessary.

Adult_Juvenile_Fish_Datasheet_Template:
https://cadwr.app.box.com/s/n9s0t9py1kir3dtomdhpf296x84fpt0x/file/1163583888368

Adult_Juvenile_Fish_Datasheet_Template_Example:
https://cadwr.app.box.com/s/n9s0t9py1kir3dtomdhpf296x84fpt0x/file/1163582593052

Larval_Fish_Datasheet_Template:
https://cadwr.app.box.com/s/n9s0t9py1kir3dtomdhpf296x84fpt0x/file/1163582625914

Larval_Fish_Datasheet_Template_Example:
https://cadwr.app.box.com/s/n9s0t9py1kir3dtomdhpf296x84fpt0x/file/1163580420616

Appendix IV- Examples of Data Sheets Currently in Use

Below you will find examples from different agencies of fish data collection field sheets. These are additionally provided as a resource to aid in developing your own datasheets.

CDFW, Fish Restoration Program:

FRP Datasheet:
https://cadwr.app.box.com/s/n9s0t9py1kir3dtomdhpf296x84fpt0x/file/1163578632279

DWR, Aquatic Ecology Program:

Yolo Bypass CHN Datasheet:
https://cadwr.app.box.com/s/n9s0t9py1kir3dtomdhpf296x84fpt0x/file/1163583142772

Yolo Bypass Datasheet:
https://cadwr.app.box.com/s/n9s0t9py1kir3dtomdhpf296x84fpt0x/file/1163583499809

USFWS, Delta Juvenile Fish Monitoring Program

DJFMP Datasheet:
https://cadwr.app.box.com/s/n9s0t9py1kir3dtomdhpf296x84fpt0x/file/1163593011342

USFWS, Enhanced Delta Smelt Monitoring Program

Kodiak Trawl Datasheet:
https://cadwr.app.box.com/s/n9s0t9py1kir3dtomdhpf296x84fpt0x/file/1163584349102

20mm datasheet:
https://cadwr.app.box.com/s/n9s0t9py1kir3dtomdhpf296x84fpt0x/file/1163593157335

Daily Summary Sheet:
https://cadwr.app.box.com/s/n9s0t9py1kir3dtomdhpf296x84fpt0x/file/1163592963319