

# California Fish Passage Assessment Database Project

## METHODOLOGY AND DATA STANDARDS DOCUMENTATION

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## **Introduction**

The Passage Assessment Database (PAD) provides a common framework for the collection, management and analysis of known and potential barriers to fish passage in California streams. It is designed to capture a set of basic information about each potential barrier to aid in inventorying and assessing fish passage issues on a statewide scale, and aid in restoration efforts. The set of data fields included in the PAD were chosen to meet the needs of the [California Fish Passage Forum](#), an association of public, private and government organizations, with the mission to protect and revitalize anadromous fish populations in California.

The PAD is an ongoing map-based inventory of known and potential barriers to anadromous and resident fishes in California. The PAD compiles currently available fish passage information from hundreds of data sources and references and allows past and future barrier assessments to be standardized and stored in one place. The inventory can be used to identify barriers suitable for removal or modification, to restore spawning and riparian habitat, and reduce stream fragmentation.

The PAD is intended to be compatible with a variety of other data sources related to fish issues and can be incorporated into tools and resources developed by partners and stakeholders. An example of this is the PAD's use as a key data input to [FISHPass](https://fishpass.psmfc.org) (<https://fishpass.psmfc.org>), a web-based decision-support tool developed by the California Fish Passage Forum, to help users identify and prioritize fish passage barriers for remediation. This optimization model relies heavily on barrier information from the PAD including the spatial layout of the barriers and cumulative barrier passability derived from barrier statuses, as well as other key data inputs such as potential upstream habitat and optionally, estimated costs.

All PAD records are saved with geographic location information (coordinates) with a small number of exceptions explained in the ***Data Quality and Limitations*** section of this document. Datasets with geographic locations are aligned to streams in which they are located on. Each are referenced to standardized hydrography, enabling PAD data to be combined with other fisheries data tied to the same hydrography. A detailed description of the digitizing process and the hydrography used can be found in the ***Passage Locations*** section of this document.

The PAD database is publicly available via the CalFish website (<https://www.calfish.org/pad/>), where the data can be accessed in a map viewer, tabular query system or downloaded as a geospatial file compatible with GIS software or Google Earth via the "data access" tab. These applications are updated three times a year with new barrier entries and updates.

All original sources and references are indexed and archived. Most references were converted to an electronic format and provided to a number of digital libraries including the [StreamNet library](#) and the University of California Berkeley Water

Resources Center Archives. PAD references can be searched and downloaded under the [CDFW document library](#). Please contact the PAD Administer if you need help accessing a reference in the document library. Contact information is available on the first page of this document.

To address needs for custom-built reports and queries of the fish passage barrier data, the PAD was enabled on the [CDFW data portal](#), where users define search criteria, view tabular data summaries and reports, export tables, map individual PAD records in an online map viewer, as well as link to site photographs and source documentation (i.e., assessment reports) from the regularly updated PAD database. Coordinates are also available for download. The PAD data portal is updated the day after changes are made.

The PAD is a “living” resource, and while updated information is incorporated as quickly as possible, the information it contains will never be perfectly up to date as conditions in the field are constantly in flux. There are certain aspects of the PAD that are particularly lacking information. Some of these data gaps include:

- natural limits to anadromy,
- barrier assessments, especially those within estuaries and other tidal regions,
- species and life stages blocked by the barrier, and
- barrier removal project data.

## **Database Structure**

The most important data collected about barriers in a state-wide inventory of fish passage issues are those related to their status and type, and the status of a structure or site refers to the degree to which it is impassable. The degree of severity of a barrier (i.e., low, moderate and severe) has also been identified as an important data gap, and efforts are underway to add this to the PAD in the future. The following includes the definitions for each category of passage status, and type of structure or site.

### **Categories of Passage Status:**

- *Total*: A complete barrier to fish passage for all species at all life stages at all flows.
- *Partial*: Only a barrier to certain species or life stages.
- *Temporal*: Only a barrier at certain flows.
- *Temporal and partial*: Only a barrier to certain species or life stages and only at certain flows.
- *Not a barrier*: Structure/site has been determined not to be a barrier to any species or life stages, and is passable at all flows.
- *Remediated, fish response unconfirmed\**: The barrier has been remediated, however, no evidence has yet been provided of fish presence above the remediated site. Evidence of fish presence above the site must be either quantitative (fish counts) or qualitative (fish photos).
- *Structure may not still be in existence*: Data were obtained from an old dataset and are likely to have been removed or washed away.
- *Unknown*: Structure/site has been visited or surveyed; however, dataset has no conclusive information about barrier status.
- *Unassessed*: The structure/site hasn't been visited and/or surveyed for fish passage.
- *Screened*: Fish screen is present on a water diversion and meets CDFW and/or National Oceanic and Atmospheric Administration's (NOAA) Fisheries screening criteria for salmon, steelhead or delta smelt.
- *Unscreened*: Water diversion without a fish screen or does not meet CDFW and/or National Oceanic and Atmospheric Administration's (NOAA) Fisheries screening criteria for salmon, steelhead or delta smelt.
- *Offstream/Unrated*: Water pond or a reservoir located off-stream.
- *Unknown/Diversion*: Water diversion with an unknown presence of a fish screen.

\* This category will be removed after ~September 30, 2022 once all records are migrated over to the revised data standards as part of a plan to update the PAD discussed below in this document.

### Types of structures or sites:

- *Dam*: A structure built across a stream or river to obstruct the flow of water. Includes debris, earth, rock, flashboard, drop structure, arch, weir, gravity, wing gabion, etc. If the barrier obstructs the flow of water and the original data source did not indicate whether the barrier was built for this purpose, it will be assumed to be a dam until other information is available.
- *Road crossing*: A structure crossing a creek or stream that allows water underneath or over the road. Includes culvert, bridge, low-flow, etc.
- *Utility crossing*: Some type of utility line, water, gas, etc. that crosses a creek or stream.
- *Diversion*: A place where the flow of water has been diverted from one course to another or directed in order to control the drainage from a section of ground. Includes screened and unscreened water diversions.
- *Flood control channel*: Any partially or completely excavated channel intended to convey above-normal discharges.
- *Grade control*: Stabilizing weirs constructed in the streambed to prevent lowering of the channel bottom. This includes installed bedrock chutes.
- *Flow measurement weir*: A notch or depression in a levee, dam, embankment or other barrier across or bordering a stream, through which the flow of water is measured or regulated.
- *Gravel/borrow pits*: Excavated area where materials have been removed for use as fill elsewhere.
- *Fish passage facility*: Provide fish passage past obstructions that would otherwise prevent or hinder their upstream progress. These include Step-and-pool, Denil ladders, and Alaskan steep-pass types.
- *Non-structural*: Anything naturally occurring that restrains or obstructs passage. Includes waterfall, grade, temperature, subterranean flows, landslide, velocity, predation, etc.
- *Tidegate*: A structure that limits the tidal flow within an estuary.
- *Log Debris Accumulations*: Large accumulations of logs and debris which form a barrier, block flow or create a waterfall. Can be either human-induced or a natural feature.
- *Other*: Any structure type not included in the above list (type is noted in the site/passage name or site comments/notes).
- *Unknown*: Dataset does not specify the structure/site type.

The PAD incorporates the barrier ranking criteria recommended in [Section IX of the California Salmonid Stream Habitat Restoration Manual](#) published by the Department of Fish and Wildlife. Terminology used for the passage status is also consistent with Section IX (Table IX-1, page IX-1).

To see a more complete list of information captured in the PAD, please refer to the [PAD metadata](#) document.

### NHD Tracing Barrier Analysis:

To assist with coarse filtering of known fish passage barriers for restoration consideration in the California Fish Passage Forum's optimization tool *FISHPass*, an additional field was added into the PAD geospatial file. The field, 'Miles\_Upst' (miles upstream), was derived from a network analysis using PAD records and National Hydrography Dataset Plus (NHD+) flowlines (NHDPlus Vers. 2.1). The field captures the length of upstream potential anadromous (or resident Southern California Rainbow Trout) habitat to the next known PAD barrier or the estimated limit of potential habitat, if applicable. Only known barriers were used for the analysis; barriers with unknown passage status, unassessed structures, non-barriers, diversions and sites where remediation occurred were excluded from the analysis. Also, only barriers within known anadromous watersheds, and select non-anadromous watersheds (i.e., Upper Klamath River), were included in the analysis. See the *FISHPass* website (<https://fishpass.psmfc.org>) for more details.

## **Passage Locations**

All PAD records are stored with geographic location information with a small number of exceptions. Each barrier record is indexed to the High-resolution National Hydrography Dataset (NHD) developed by United States Geological Survey at a 1:24,000 or finer scale. The NHD was used to assign a stream address to a PAD record. Using the 'Locate feature along route' command (ArcGIS 9.3 and later), each barrier was assigned a position along the measured stream network by capturing the unique identifier for each line segment (ComID) and the measure (feet) along the segment that represents the barrier location.

For simplicity, all barriers were standardized as point features. Downstream ends of linear barriers such as flood control channels, gradients or low-flow sections were digitized as points, based on the assumption that the adult fish swimming upstream will have to deal with the downstream end of a barrier first. The length of the linear barriers can be found in the site comments/notes for each.

Since some of the fisheries related datasets in California are tied to the LLID-based routed hydrography of a 1:100,000 scale (rather than the NHD), the PAD is also available in a format compatible with the LLID hydrography.

All geographic data that are received for use in the PAD are saved in their original format as well as in their final standardized format. If there are any problems with the PAD data, it will always be possible to return to the original dataset for a solution.

## **Data Quality and Limitations**

The PAD was compiled using information about fish passage from a large number of sources. These datasets were originally created for a number of different purposes, from general stream habitat surveys to rigorous assessments of fish passage barriers. As a result, the datasets vary widely in the type, amount, and quality of data they contain. The following are brief descriptions of the data quality issues and limitations of the data in the PAD.

1. **PAD Reflects Best Efforts to Include Known Information:** The data in the PAD reflect the datasets that have been found to date by PAD staff, which may not reflect the current state of fish passage in streams. For example, the PAD includes very comprehensive data about passage barriers in some watersheds, but not in others. This does not mean that there aren't many barriers in the other watersheds, but rather that the PAD does not yet include comprehensive barrier data for these watersheds.
2. **Lag Between Project Completion and PAD Updates:** The PAD Administrator strives to keep the data as current and updated as possible, however, there can be a lag between when on the ground projects are implemented and/or completed and when that information is provided to the PAD. For example, some programs and organizations report project completion annually and sometimes there is a lag between when a project is completed on the ground and when it is reported.
3. **Missing Information May Result in “Unassessed” or “Unknown” Classifications:** Many datasets do not include an assessment of whether or not an inventoried structure or non-structural feature (i.e., waterfall) are barriers to fish passage, information as to if/when they were surveyed, and the passage status (i.e., partial, temporal or total) of these structures or features. Non-surveyed structures or features are listed as “unassessed”. Other structures may have had some level of survey for fish passage but passage status was indeterminate and/or needs further assessment and analysis (i.e., using Caltrans Detailed Survey or [FishXing](#)); and therefore, are listed as “unknown” passage status.
4. **Incomplete Data Sources Impact PAD Data:** Many datasets are missing information that should be included in the database. For example, many datasets do not have species information indicating which species and life stage are blocked by the barrier and the level of blockage (i.e., temporal or total).
5. **Location Information Inaccuracies:** In some cases, the datasets provided to the PAD do not include precise location information. For example, some stream surveys only mention that there is a barrier or structure within a defined reach of stream, making it difficult to pinpoint the barrier location. Structures described in this way are maintained in the GIS as linear geospatial files. For the purposes of creating one point feature spatial file, all linear locations were converted to a single point at the beginning of the linear stream reach. Location inaccuracies



have led to duplicative barrier records.

6. **Structure Locations Referenced to the Hydrography:** Some datasets describe locations using the distance of the structure from the stream mouth (i.e., river mile) – these were digitized using this measure on the hydrography. Since the 1: 24,000 hydrography may not follow the exact course of the stream and stream measures may not be precise, measured distances along a stream may not reflect reality. This has resulted in location errors leading to duplicate barrier entries. Errors are minimized by referencing structures to other landmarks whenever possible.
7. **Latitude/Longitude Coordinates Snapped to Hydrography:** Datasets with location information in latitude/longitude coordinates were snapped to the hydrography to standardize all location data in the PAD. This means that the points were shifted from the coordinates given in the original dataset, and the locations in PAD do not reflect the actual location of the point. Original coordinates are kept with the original data set. Additionally, some locations were snapped to the wrong stream and these were not diligently checked. These will need to be identified and corrected.
8. **Duplicate Records Due to Overlapping Geographic Ranges:** Some datasets overlap in their geographic range, and information about the same potential barrier can sometimes be found in several different datasets. In most cases, the duplicates are identified during data entry or in subsequent data quality evaluation. However, the database may still contain duplicates.
9. **Missing Spatial Information:** There are some passage records in the database that do not have any spatial information associated with them. This is either due to locations in the original datasets that did not make sense or because the original dataset did not include any spatial information. There are slightly more passage records in the database than in the spatial files that are displayed on maps.

To remedy the issues identified in #1 through #8 above, outreach efforts are continually being conducted to gather updated and comprehensive data. A systematic effort to remedy these issues, as well as identify and correct other issues (i.e., inconsistencies in naming conventions including stream names and landowners/structure owners), has been outlined in a plan to update the PAD. Implementation of this plan was initiated in 2021.

Additionally, in an effort to reduce the data quality issues described above in #5 through #8, PAD Data Standards described in this document on the next page were developed in 2013 in collaboration with the CDFW and PSMFC and updated in 2014 and 2021. These standards specify who determines barrier status and quality assurance and quality control procedures. The standards will be implemented for all records upon completion of the plan referenced above.

## **Data Standards**

In order to create a robust dataset of fish passage barriers in the state of California new Passage Assessment Database standards were created on January 2013 and revised in 2014 in collaboration with the California Department of Fish and Wildlife and Pacific States Marine Fisheries Commission. In 2021, these data standards were further refined with input from members of the California Fish Passage Forum.

The original standards took effect in 2013 for all new records. All existing records in the PAD will be migrated over to the new standards in the future (~September 30, 2022). These standards will be reviewed every three years and edited as deemed necessary. The following standards represent the PAD Standards first developed in January 2013 and revised on January 2014 and June 2021. The January 2014 updates include clarification of each standard, grouping them into common subjects, and deleting the standard that specified that diversions will not be snapped to the standard hydrography.

The June 2021 updates include modifications to Standard #11 to include barriers in Oregon on water bodies that flow in and out of California, Standard #10 to remove the status of “remediated, fish presence unconfirmed” and provide direction on how to address remediated barriers, and the addition of standards for management barriers and minimum criteria for updating PAD. Additionally, these updates include the deletion of standards that specified barriers in close proximity acting as one unit will be recorded as one barrier, and only including the barrier status of a particular species and lifestage in the PAD if there was a field survey or if FishXing software was used.

Standard hydrography in this document refers to high resolution hydrography developed by United States Geological Survey at a 1:24,000 or finer scale.

## PAD Standards, June 2021 Version

Category	Standard #	Standard and description of the standard. Standards are listed below in bold font below, followed by a description of the standard in plain text.
Communication	1	<b>Passage information obtained in-person or via a telephone will be recorded as written documentation and so will the form for providing updates to the Passage Assessment Database.</b> Telecon, in-person communication memos and emails are recorded as references in the PAD but are not uploaded to the CDFW Document Library or any other online data storage location (e.g., StreamNet). The form for providing updates to the PAD will be recorded as a reference in the PAD and uploaded to the CDFW Document Library. These forms will not be made public.
	2	<b>Once a barrier has been added or updated in the PAD, the contributor who submitted the information will receive an email confirmation</b> that includes information about when and where their updates will be viewable, and the relevant PAD ID number(s), as needed, for future reference.
Individual and Combined Records	3	<b>Multiple barriers (same type) at the same location will be captured in one PAD ID and the number of barriers will be added to a new field.</b> If the passage statuses differ between these barriers, the most passable passage status will be associated with the PAD ID and the passage statuses of all barriers will be noted in the site comments. For example, if there are two culverts next to one another under the same bridge one that is a total barrier and the other that is a partial barrier, this will be combined into one PAD ID (i.e., one point) and listed as a partial barrier. The site comments will contain the passage status of both culverts.
Location	4	<b>All records in the PAD will be aligned to the standard hydrography and their locations will be revised so that they are on top of the barrier per aerial imagery but still aligned to the hydrography.</b> The locations of the PAD records will differ from the GPS coordinate provided by the data source.
	5	<b>Imprecise coordinates due to lack of access will not be added to the PAD.</b> If coordinates aren't precise because entry onto the property was prohibited and the barrier can't be seen from aerial imagery or LiDAR, this barrier entry will not be added in the PAD.
Passage Status	6	<b>If passage status using professional judgement did not come from a fish passage professional, the passage status will be verified by a fish passage professional.</b> If the assessment of passage status did not come from a fish passage professional, list the passage status as unknown until a fish passage professional has confirmed or disputed the sources' passage assessment. A fish passage professional is a person who has had some educational or work experience in fish passage or was trained in evaluating passage.

Category	Standard #	Standard and description of the standard. Standards are listed below in bold font below, followed by a description of the standard in plain text.
Passage Status	7	<b>Where two or more fish passage professionals have differing opinions as to the passage status using professional judgment, all parties will be contacted and they will need to come up with a resolution as to the barrier status before it is updated in the PAD.</b> This only includes current opinions as the barrier status can change over time. When assessment data is available it will be updated in the PAD.
	8	<b>Where there is substantial current evidence of fish use above a previously estimated complete barrier (i.e., where CDFW’s Restoration Manual’s red-gray-green filter or FishXing was used), the passage status will be downgraded to a partial or temporal barrier based on professional judgement by a fish passage professional.</b> This will more accurately identify the status of barriers. There are several instances where fish have been observed above a feature identified as a complete barrier using these and other criteria that estimate passage.
	9	<b>A structure or non-structural element (i.e., waterfall, grade, temperature, etc.) will be added to the PAD and listed as ‘unassessed’ passage status if the passage status is unknown and if the barrier is a probable or potential barrier and hasn’t been assessed.</b> For instances where barriers are probable partial or probable total barriers, this information will be added to the site comments.  <b>The barrier status of these structures will be listed as ‘unknown’ if they have been assessed but the passage status was unable to be determined.</b> U.S. Forest Service Grey filter category (i.e., indeterminate) is an example of this.
	10	<b>Once a barrier is removed, and the remediation meets fish passage criteria (e.g., CDFW or NOAA), the passage status will be updated to reflect whatever passage status is deemed by the criteria cited (partial, temporal, not a barrier, etc.).</b> If an assessment of the site/barrier is made at a later date and the passage status is deemed to have changed an update will be made to the PAD according to the standards and methodology in this document.
Geographic Focus	11	<b>Only barriers within the state of California will be added to the PAD with the exception of barriers in Oregon on water bodies that flow into and/or out of California.</b>

Category	Standard #	Standard and description of the standard. Standards are listed below in bold font below, followed by a description of the standard in plain text.
<b>Quality Assurance and Quality Control</b>	12	<p><b>All barriers and diversions will be subject to the Quality Assurance and Quality Control (QAQC) procedures listed below, to the extent that this is possible.</b> The QAQC procedures include verification of location information and steps for the prevention of duplicate barriers and diversions in the PAD.</p> <p>a) When receiving barrier and diversion information, use ArcMap to decide if these are new barriers and diversions that need to be added to the PAD. Look at PAD barriers and diversions within proximity of this new site, compare photos, site names, structure owners, passage statuses, passage types and site comments. If it is still difficult to determine if this is a new site, request more information from the source. In many cases, existing barriers in PAD are incorrectly located and can often be off by more than several hundred feet.</p> <p>b) Verify with the source that the coordinates are precise (i.e., taken on top of the barrier) and ask for the datum used if not provided.</p> <p>c) When sources send information that have may have duplicate information, send an email back to the source addressing these issues.</p> <p>d) Snap the barrier to the standard hydrography and verify that the snapped barriers are on the correct stream and road route/post-mile. Check the physical location of the barrier against road route/post-mile, stream name and/or stream mile listed in the data and verify that the snapped location is on top of the barrier per aerial imagery.</p>
<b>Minimum Data Requirements</b>	13	<p><b>Submissions of barriers not already existing in the PAD should include the following minimum criteria:</b> geographic coordinates and datum, stream name, barrier or site name, site type (dam, road crossing, etc.), passage status, protocol used to determine status and the agency that made the determination, species and/or life stage that were evaluated, survey date (if known/applicable), type of fishway and status (if applicable), and a description of the structure and passage impediments, if available.</p> <p>If other information is available outside the minimum requirements listed above, please include that in the submittal. Examples include ownership information, photos, habitat quantity and quality, and cost to remediate a barrier, etc.</p>

Category	Standard #	Standard and description of the standard. Standards are listed below in bold font below, followed by a description of the standard in plain text.
<b>Minimum Data Requirements</b>	14	<p><b>Updates to barriers already in the PAD should include the following information at a minimum:</b></p> <ul style="list-style-type: none"> <li>a) <b>Passage information:</b> PAD ID and/or geographic coordinates and datum, passage status, protocol used to determine status and the agency that made the determination, species and/or life stage that were evaluated, survey date (if known/applicable), type of fishway and status (if applicable), and a description of the structure and passage impediments, if available.</li> <li>b) <b>Completed fish passage improvement projects:</b> PAD ID and/or geographic coordinates and datum, date/removal of remediation, description of type of remediation that occurred (i.e., replaced double box culvert with a free span bridge) including the type of fishway installed (pool and weir, v-notch, etc.)</li> <li>c) <b>Screening projects:</b> PAD ID and/or geographic coordinates and datum, date that the water diversion was screened, type of screen, size of screen, mesh size, cubic feet per second (cfs) that the diversion was screened to (if known).</li> </ul> <p>If there was a diversion consolidation, provide the geographic coordinates for the diversions that were abandoned, the name of the streams that they are located on, and the coordinates of the consolidated diversion.</p> <p>If other information is available outside the minimum requirements listed above, please include that in the submittal. Examples include ownership information, photos, habitat quantity and quality, and cost to remediate a barrier, etc.</p>
<b>Management Barriers</b>	15	<p><b>Barriers which are generally considered to be non-detrimental to fish populations and used for management purposes will be tracked in the PAD and designated as such.</b> Examples of these types of barriers include those placed to exclude Aquatic Invasive Species from a stream section or to prevent fish from straying. These barriers will be designated as such with a new field, Management Barrier (Yes/No) and treatment needed (e.g., barrier removal/remediation) will be identified as “no”.</p>