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Title: Data system design alters meaning in ecological data: salmon habitat restoration across the U.S. Pacific Northwest

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Appendix S1. Data definitions and crosswalks between Pacific Northwest Salmon Habitat Project Tracking database (PNSHP), Pacific Coast Salmon Recovery Funding Board (PCSRF) and the National River Restoration Science Synthesis (NRRSS).

Table S1: Data dictionary for the Pacific Northwest Salmon Habitat Project Tracking database (PNSHP).

PACIFIC NORTHWEST SALMON HABITAT PROJECT TRACKING DATABASE

Project Type	Sub-Type	Definition
Barrier Removal *Projects that improve fish passage.*	**Culvert Improvements/ Upgrade**	Improve an existing culvert; some culvert upgrades may be culvert replacements that were not specified as such.
	Culvert Installation	Add a passable culvert where none previously existed; the installed culvert may be a replacement that was not specified as such.
	Culvert Removal	Culvert taken out (often replaced by a non-blocking structure such as a bridge or removed because the structure it was associated with was removed, a road etc.)
	Culvert Replacement	Exchange an existing culvert with a new culvert; replacement wasn't specified as an improvement/ upgrade.
	Dam Removal	Elimination of a dam that isn't specified as a push-up or diversion dam.
	Push-up dam/ Diversion dam removal	Elimination of a push-up dam (earthen dam), or removal of a diversion dam (permanent structure); both can be a partial or full passage barrier.
	Fish By-pass	A way around a barrier, usually a side channel; any by-pass that isn't specified as a fish ladder.
	Fish Ladder	Structure with a series of ascending pools providing passage for salmon around a dam; used if fish ladder was not specified as either new or improved.
	Fish Ladder Improved	Upgrade on an existing fish ladder.
	Fish Ladder Installed	Placement of a fish ladder where there was not one previously.
	Log Jam/ Debris Removal	Elimination of a naturally forming log or debris jam that created a passage barrier.
	Other	Project did not describe or specify the type of barrier removal i.e. "project will remove passage barrier".
	Tidegate	An opening through which water may flow freely when the tide goes in one direction, but which prevents the water from flowing in the other direction; project includes elimination of, or changes to a tidegate that result in fish passage at low and high tide.
	Weir	Low dam that is a passage barrier to fish; project includes modifications or removal that allow passage.

Diversion Screens *Projects that involve placing fish screens on irrigation diversions and thereby keeping juvenile fish from being pumped onto fields with irrigation water.*	**Fish screen**	Screen added to an unscreened diversion to keep juveniles from being diverted into irrigation ditches or canals (or it was a fish screen replacement that wasn't specified as such).
	Fish screen replacement	The existing fish screen was exchanged by a new or improved screen.
Sediment Reduction *Projects the diminish excessive sediment transport into streams.*	**Erosion Control Structures**	Construction of installations used to minimize erosion e.g. hillside stabilization, grassed waterways.
	Other	Any sediment reduction action that did not fall into one of the other subtypes or was defined too poorly to assign it to a subtype e.g. rail closures, campground closures.
	Road Closing/ Abandonment	Road is no longer accessible to motorized vehicles. Area may or may not have been rehabilitated (road decommissioning) and project was not specified as a road relocation.
	Road Drainage	Placement of structures to contain or control run-off from roads. Includes surface drainage, peak flow drainage improvements and roadside vegetation.
	Road Relocation	Abandonment of an existing road in riparian area or streambank/ streambed and may or may not have been rehabilitated. A new road was constructed in a less sensitive area.
	Rocked Ford	Construction of a reinforced rock roadbed that crosses the stream (for livestock or vehicles) without restricting the stream flow.
	Sediment Traps	Sediment capture structures including sediment basins and sediment ponds.
Restore Stream Complexity - Channel Complexity *Projects involving the stream channel or any lateral hydrologic feature. All wetted channel restoration or reconfiguration including estuary and near shore.*	**Bank Stabilization**	Placement of streambank supports including the use of rock barbs, log barbs, revetments, gabions etc.
	Beaver Introduction/Management	Introduction or management of beavers to add stream complexity (beaver dams, ponds, etc).
	Channel connectivity	Reconnecting (historic) or linking existing channel with stream channels, wetlands, and/ or off-channel habitat or floodplain habitat.
	Channel reconfiguration	Changes in channel morphology e.g. pools added/ created, meanders added, former channel bed restored.
	Dike reconfiguration	Restructuring of an embankment to confine or control water built along the banks of a river to allow for more connectivity with the river.
	Dike removal	Elimination a barrier constructed to contain the flow of water along the river to prevent flooding.

	Off-channel habitat	Project included restoration/ reconnection of off-channel habitat but the specific type of off-channel habitat was not specified. Off-channel habitat consists of side-channels, backwater areas, alcoves or side-pools, off-channel pools, off-channel ponds, and oxbows.
	Off-channel habitat: alcove	Alcove habitat created, restored, or reconnected to main channel.
	Off-channel habitat: pond	Pond habitat created, restored, or reconnected to main channel.
	Off-channel habitat: side channel	Side channel habitat created, restored, or reconnected to main channel.
	Other	Unspecified channel complexity project ' this project will restore the stream channel', or project that did not fall into any of the identified subtypes.
	Wetland creation	Wetland (including estuary) area installed where it did not previously exist.
	Wetland improvement/ enhancement	Augmentation of an existing wetland (or estuary).
	Wetland restoration	Rehabilitation of existing or historic wetland (or estuary).
Restore Stream Complexity - Instream Structure *Projects involving the stream channel or any lateral hydrologic feature. Projects that place structures in the stream channel.*	**Boulders**	Large rocks or boulders added to stream channel.
	Deflector	Placement of triangular structures of rock or logs that extend into the stream to narrow and deepen the channel.
	Gravel Placement	Addition of salmon spawning gravel to the channel.
	Rock Weir	Placement of a passable low rock ledge across the stream.
	Log Weir	Placement of a passable log ledge across the stream; also called a log drop structure.
	Weir	Placement of a weir not specified as a rock or log weir.
	Other	Instream structure type not specified in project description e.g. ‘project will improve in stream habitat’, or a project that did not fall into any of the identified subtypes.
	Large Woody Debris	Placement of logs in the streambed that are not part of engineered structures or log jams, as well as all other large woody debris not specified as root wads.
	Rootwads	Placement of a stump with roots attached extending into the stream specifically described as rootwad(s).
	Structure/ Log jam	Placement of engineered structures of multiple logs fastened together in the stream.
Nutrient Enrichment*Projects that add nutrients to the streambed via various means.*	**Carcass Placement**	Salmon carcasses added to stream to provide (marine derived) nutrients.
	Fertilizer	Fertilizer placed in stream to increase nutrient availability.
	Other	Nondescript 'stream nutrient improvement' projects.
Restore Instream Flow	**Instream Water Rights**	Purchase of water rights. These water allocations are not withdrawn from the stream.

Projects that return water to the stream.	**Reduce/ Regulate water withdrawal**	Any water efficiency improvement generally in irrigation systems, for example installation of a headgate with water gauge that controls water flow into irrigation canals on previously unregulated diversions or piping of previously open irrigation ditches to control water loss. Also the addition of other water sources (wells etc.) so that stream water is used less.
	Water Quantity	Non-specific instream flow projects i.e. 'project will increase instream flow'.
Restore Riparian Function *Projects that restore and protect the riparian zone adjacent to streams.*	**Fencing**	Fencing to exclude livestock and other riparian fencing.
	Forestry practices	Forest management practices that include prescribed burns, stand thinning, stand conversion, silviculture, and vegetation management.
	Livestock Removal	Elimination of livestock from riparian areas.
	Livestock Rotation	Alternating livestock grazing areas to minimize impact on riparian areas.
	Livestock Stream Crossing	The fencing of a livestock stream crossing. Also called a water gap.
	Off-channel Watering	Supplying an alternate water source for livestock to keep them out of the stream. Also called livestock water development or livestock water supply.
	Other	Projects occurring in the riparian zone that gave no details beyond 'the project will restore riparian function' or do not fit into any of the subtype categories.
	Plant installation/ revegetation	Establishment of plants in the riparian zone. Includes conifer planting and native plant establishment.
	Plant removal/ control	Elimination or control of non-native plants and noxious weed species, and other plants.
Water Quality Improvement Projects that improve stream water quality parameters.	**Other**	Projects stating ' this project will improve water quality' that gave no further details.
	Refuse removal	Removal of garbage and abandoned items in the waterway.
	Temperature controls	All projects with a goal of reducing water temperature. Most are return flow cooling projects which generally consist of replacing old open return ditches with underground PVC pipe which allows the water to cool before entering the river.
	Toxic clean up	Removal of toxic substances from the area surrounding the stream e.g. mine tailings clean-up, chemical clean-up.
Upland Management *Projects occurring in the upland but generally close enough to the stream that they may have some kind of impact.*	**Agriculture Management**	Crop management to reduce sediment outputs, nutrient discharge and water usage e.g. low/ no till agriculture, best management practices.
	Erosion Structures	Agricultural and road related sediment control including sediment basins, wind breaks, waterbars and road drainage.
	Fencing	Installation of exclusion and non-exclusion fencing, generally to contain livestock.
	Invasive Plant Control	Removal and control of non-native plants and noxious weeds.
	Livestock	Any upland cattle management; includes watering and

	Management	grazing management plans.
	Planting	Upland plant installation, seeding, and revegetation.
	Slope Stabilization	Slope stabilization methods including landslide reparation and terracing.
	Vegetation management	Vegetation and forestry actions including prescribed burns, stand thinning, stand conversion, silviculture, vegetation management, selective thinning, and hazard reduction.
	Water Development	Irrigation and livestock water development including ditches, wells, ponds, springs etc.
	Other	Upland improvement projects with few details or any project that didn't fit into the other subtype categories.
Other *Projects in this category did not have enough information to determine project type and if the project would positively affect habitat.*	**Bridge**	These are generally bridge replacement projects. We were unable to tell if the project had any fish passage or sediment reduction benefit.
	Culvert	Projects that involved culvert placement or removal that did not make any connection between the culvert activity and fish passage.
	Fencing	Projects that installed fencing that did not appear to be related to livestock removal from the riparian zone.
	Flood Control	Projects to control the reach to flood waters. These may include dikes, piping etc. Projects of this type may create fish passage barriers.
	Irrigation Diversion	Projects that installed headgates and irrigation systems; fish passage and water withdrawal conservation were not mentioned as goals.
	Other	Projects with very little or no information that came in a data set with restoration projects so they are likely to be restoration projects but could not be classified.
	Road	Any projects where road work did not appear to be tied to fish passage or sediment reduction concerns.
	Water Control Structures	The use of water control structures to restore wetlands for birds and wildlife in areas that could not be determined to be associated with a stream.
	Water Development	Irrigation systems and cattle watering system development including ditches, ponds, springs, and wells. Some of this development may reduce water use or provide off-channel watering for cattle but this was not clear from the descriptions.
	Wetland Management	Projects to restore, enhance or create wetlands where it could not be determined if the wetland was connected to a stream.

Table S2: PNSHP to Pacific Coast Salmon Recovery Funding Board (PCSRF) crosswalk.

PCSRF Type	PCSRF Definition	PNSHPT Type	PNSHPT Subtype
Fish Screening Projects	**Projects that result in the installation or improvement of screening systems that prevent Salmonids from passing into areas that do not support salmonid survival, for example into irrigation diversion channels.**	Diversion Screens	All subtypes
Fish Passage Improvement Projects	**Projects that affect or provide fish migration up and down stream including road crossings (bridges or culverts), barriers (dams or log jams), fishways (ladders, chutes or pools), and weirs (log or rock).**	Barrier Removal	Culvert Improvements/Upgrade
		Barrier Removal	Culvert Installation
		Barrier Removal	Culvert Removal
		Barrier Removal	Culvert Replacement
		Barrier Removal	Dam Removal
		Barrier Removal	Push-up dam/ Diversion Dam Removal
		Barrier Removal	Fish By-pass
		Barrier Removal	Fish Ladder
		Barrier Removal	Fish Ladder Improved
		Barrier Removal	Fish Ladder Installed
		Barrier Removal	Log Jam/Debris Removal
		Barrier Removal	Other
		Barrier Removal	Weir

Instream Flow Projects	**Projects that maintain and/or increase the flow of water to provide needed habitat conditions. These can include releases of water from dams or impoundments or water conservation projects to reduce stream diversions or extractions.**	Restore Instream Flow	All subtypes
Instream Projects	**Projects that increase or improve the physical conditions within the stream environment (below the ordinary high water mark of the stream) to support an increased salmonid population. Includes: Bank stabilization, carcass placement, channel connectivity, channel reconfiguration, deflectors/barbs, log control (weir), off-channel habitat wetland, plant removal/control, rock control (weir), roughened channel, signage, site maintenance, pawning gravel placement, woody debris placement, stream channels, other.**	Nutrient Enrichment	All subtypes
		Restore Stream Complexity - Channel complexity	Bank Stabilization
		Restore Stream Complexity - Channel complexity	Channel Connectivity
		Restore Stream Complexity - Channel complexity	Channel Reconfiguration
		Restore Stream Complexity - Channel complexity	Off-channel habitat
		Restore Stream Complexity - Channel complexity	Off-channel habitat: alcove
		Restore Stream Complexity - Channel complexity	Off-channel habitat: pond
		Restore Stream Complexity - Channel complexity	Off-channel habitat: side channel
		Restore Stream Complexity - Channel complexity	Other
		Restore Stream Complexity - Instream Structure	All subtypes

Riparian Habitat Projects	**Projects that change areas (above the ordinary high water mark of the stream and within the flood plain of streams) in order to improve the environmental conditions necessary to sustain Salmonids throughout their life cycle. Includes: Planting, fencing, livestock exclusion, water gap development, conservation grazing management, irrigation practice improvement, livestock water development, weed control.**	Restore Riparian Function	Fencing
		Restore Riparian Function	Livestock Removal
		Restore Riparian Function	Livestock Rotation
		Restore Riparian Function	Livestock Stream Crossing
		Restore Riparian Function	Off-channel watering
		Restore Riparian Function	Other
		Restore Riparian Function	Plant installation/ revegetation
		Restore Riparian Function	Plant removal/ control
Upland Habitat Projects	**Landscape level projects implemented above the elevation of the riparian zone (above the floodplain) that indirectly affect salmonid habitat, for example by affecting the water quality and quantity. Upland treatments include road stream crossing improvements, road drainage system improvements, road reconstruction, road obliteration, upland erosion control - sediment control basins, upland erosion control - windbreaks, upland erosion control - planting, upland erosion control - conservation land management, no till ag, terracing.**	Sediment Reduction	All subtypes
		Upland Management	Agriculture Management
		Upland Management	Erosion Structures
		Upland Management	Planting
		Upland Management	Slope Stabilization

Water Quality Projects	**Landscape level projects implemented above the elevation of the riparian zone (above the floodplain) that indirectly affect salmonid habitat, for example by affecting the water quality and quantity. Choose from a list of water quality indicators: temperature, turbidity, bacteria, dissolved oxygen, pesticides, pH, heavy metals, nutrients.**	Water Quality Improvement	All subtypes
Wetland Projects	**Projects designed to protect, create or improve connected wetland areas (that meet the standard for federal delineation) that are known to support salmonid production. For example salmonid populations, especially juveniles, can benefit from access to connected wetland areas where conditions provide food supply, protection from high flows and protection from predators. Choose from types of wetland treatments: wetland creation, wetland improvement/enhancement, wetland vegetation planting, wetland invasive species removal.**	Restore Stream Complexity - channel complexity Restore Stream Complexity - channel complexity Restore Stream Complexity - channel complexity	Wetland Creation Wetland Improvement/enhancement Wetland Restoration
Estuarine Projects	**Projects that result in improvement of or increase in the availability of estuarine habitat such as tidal channel restoration, floodplain connectivity, floodgate fish passage or diked land conversion. This habitat is important for salmonid out migration where juvenile Salmonids begin the transition from fresh to salt**	Barrier Removal Restore Stream Complexity - Channel complexity Restore Stream Complexity - Channel complexity	Tidegate Dike reconfiguration Dike removal

	water environments and where predatory pressures are known to be high. Estuarine projects include channel modification/creation, increased freshwater flow, dike breaching/removal, tide gate alteration/removal, removal of existing fill material, creation of new estuarine area.		
NOT INCLUDED IN PCSRF		Restore Riparian Function	Forestry Practices
		Restore Stream Complexity - Channel complexity	Beaver Introduction/Management
		Other	All subtypes
		Upland Management	Fencing
		Upland Management	Forestry Practices
		Upland Management	Invasive Plant Control
		Upland Management	Livestock Management
		Upland Management	Vegetation Management
		Upland Management	Water Development
		Upland Management	Other

Table S3: PNSHP to National River Restoration Science Synthesis (NRRSS) crosswalk.

NRRSS Intent	NRRSS Definition	PNSHPT Type	PNSHPT Subtype
Aesthetics/Recreation/Education	Activities that increase community value: use, appearance, access, safety, knowledge.	NA	NA
Bank Stabilization	Practices designed to reduce/eliminate erosion or slumping of bank material into the river channel. This category DOES NOT include Stormwater Management, see next intent category.	Restore Stream Complexity-Channel Complexity	Bank Stabilization
Channel Reconfiguration	Alteration of channel plan form or longitudinal profile and/or day-lighting (converting culverts and pipes to open channels). Includes stream meander restoration and in-channel structures that alter the thalweg of the stream. Note that many instream structures also claim to improve habitat. For NRRSS the intent declared in the source document must be used.	Restore Stream Complexity-Channel Complexity Restore Stream Complexity-Channel Complexity Restore Stream Complexity-Channel Complexity	Beaver Introduction Channel Reconfiguration Other
Dam Removal/Retrofit	Removal of dams and weirs or modifications/retrofits to existing dams to reduce negative ecological impacts. Excludes dam modifications that are simply for improving Fish Passage.	Barrier Removal Barrier Removal Barrier Removal	Dam Removal Push-up Dam/ Diversion dam removal Weir
Fish Passage	Removal of barriers to upstream/downstream migration of fishes.	Barrier Removal Barrier Removal	Culvert Improvements/Upgrade Culvert Installation

	Includes the physical removal of barriers and also construction of alternative pathways. Includes migration barriers placed at strategic locations along streams to prevent undesirable species from accessing upstream areas.	**Barrier Removal** **Barrier Removal** **Barrier Removal** **Barrier Removal** **Barrier Removal** **Barrier Removal** **Barrier Removal** **Barrier Removal** **Diversion Screens**	**Culvert Removal** **Culvert Replacement** **Fish By-pass** **Fish Ladder** **Fish Ladder Improved** **Fish Ladder Installed** **Log Jam/Debris Removal** **Other** **Tidegate** **All Subtypes**
Floodplain Reconnection	**Practices that increase the flood frequency of floodplain areas and/or promote flux of organisms and material between riverine and floodplain areas.**	**Restore Stream Complexity-Channel Complexity** **Restore Stream Complexity-Channel Complexity** **Restore Stream Complexity-Channel Complexity**	**Channel Connectivity** **Dike Reconfiguration** **Dike Removal**
Flow Modification	**Practices that alter the timing and delivery of water quantity (DOES NOT include Stormwater Management). Typically, but not necessarily associated with releases from impoundments and constructed flow regulators.**	**Restore Instream Flow**	**All Subtypes**
In-stream Habitat Improvement	**Altering structural complexity to increase habitat availability and diversity for target organisms and provision of breeding habitat and refugia from disturbance and predation. (In some cases habitat improvement may be an action with the intent of In-stream Species Management, in other cases Habitat**	**Nutrient Enrichment** **Restore Stream Complexity - Instream Structure** **Restore Stream Complexity-Channel Complexity**	**All Subtypes** **All Subtypes** **Off-channel Habitat:all subtypes**

	Improvement may be the intent, and might be accomplished through Channel Reconfiguration, be very careful to separate action from intent when deciding whether to select this category.		
In-stream Species Management	**Practices that directly alter aquatic native species distribution and abundance through the addition (stocking) or translocation of animal and plant species and/or removal of exotics. Excludes physical manipulations of habitat/breeding territory (see In-stream Habitat Improvement).**	**NA**	**NA**
Land Acquisition	**Practices that obtain lease/title/easements for stream-side land for the explicit purpose of preservation or removal of impacting agents and/or to facilitate future restoration projects. Note: Simple purchase and preservation to prevent potential future land conversion is insufficient for inclusion in the NRRSS database. NRRSS projects should demonstrate intended or actual cessation of detrimental activities in acquired land or active restoration components.**	**NA**	**NA**
Riparian Management	**Revegetation of riparian zone and/or removal of exotic species (e.g. weeds, cattle). Excludes localized planting only**	**Restore Riparian Function**	**All Subtypes**

	to stabilize bank areas (see Bank Stabilization).		
Stormwater Management	**Special case of Flow Modification that includes the construction and management of structures (ponds, wetlands and flow regulators) in urban areas to modify the release of storm runoff into waterways from watersheds with elevated imperviousness into waterways. These practices/structures generally aim to reduce peak flow magnitudes and extend flow duration. For the purposes of NRRSS Stormwater Management refers to water quantity not quality. Urban sediment, litter and temperature control should be categorized as Water Quality Management.**	**NA**	**NA**
Water Quality Management	**Practices that protect existing water quality or change the chemical composition and/or suspended particulate load. Remediation of acid mine drainage falls into this category as does CSO separation. Excludes urban runoff quantity management (see Stormwater Management).**	**Sediment Reduction** **Water Quality Improvement**	**All Subtypes** **All Subtypes**
NOT INCLUDED IN NRRSS		**Other**	**All Subtypes**

		Restore Stream Complexity-Channel Complexity	**Wetland Creation**
		Restore Stream Complexity-Channel Complexity	**Wetland Improvement/enhancement**
		Restore Stream Complexity-Channel Complexity	**Wetland Restoration**
		Upland Management	**All Subtypes**