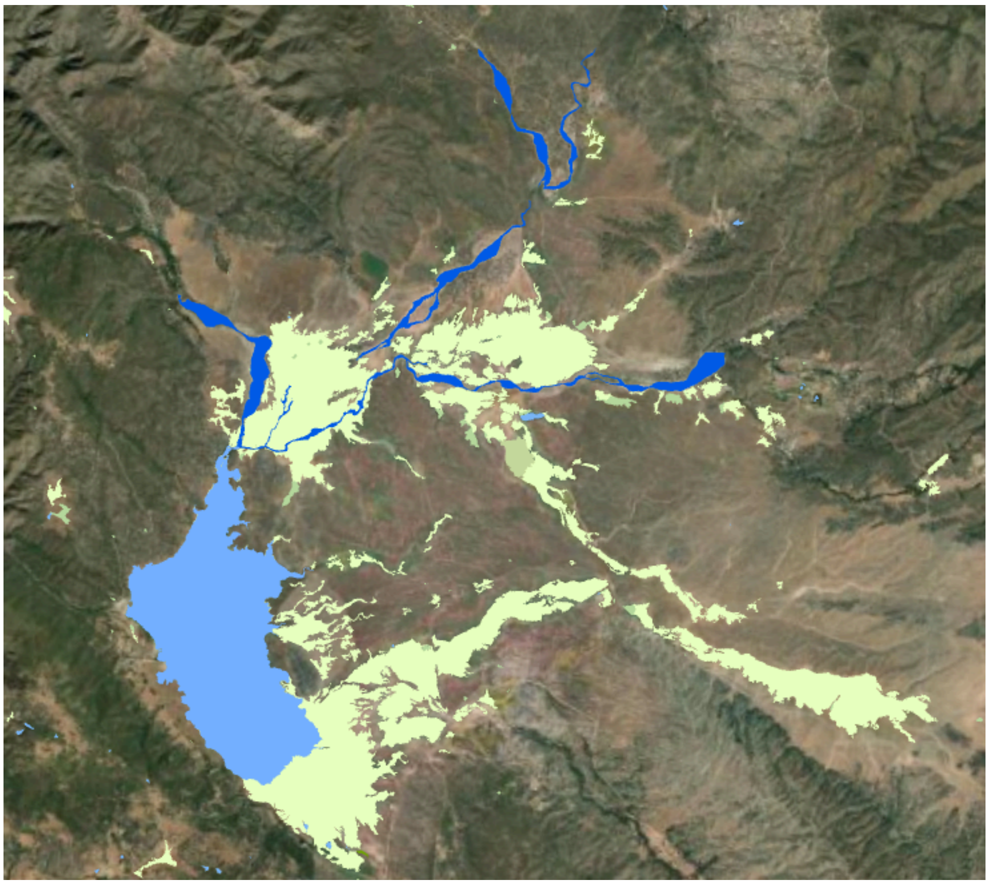
San Diego Aquatic Resource Inventory (SDARI)

MAPPING METHODS AND STANDARDS FOR CHANNELS, WETLANDS, AND RIPARIAN AREAS IN SAN DIEGO



Prepared by SFEI for
California State Water Resources Control Board

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San Francisco Estuary Institute-Aquatic Science Center
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1 Overview

Purpose

The purpose of this document is to describe the mapping classification system and methods[1] used to develop the San Diego Aquatic Resource Inventory (SDARI) in 2024. SDARI is an inventory of aquatic resources and their associated vegetated areas in the San Diego, CA area, specifically within the Water Quality Control Board Region 9. The inventory was developed in a Geographic Information System (GIS), employing a standardized, and regionally relevant classification system to support environmental planning and resource management tracking at a local and regional scale. SDARI will be integrated into the California Aquatic Resources Inventory (CARI), which is publicly accessible on EcoAtlas (www.ecoatlas.org). CARI is the statewide standardized dataset intended to support regional watershed restoration planning, tracking, and reporting.

History, Previous Studies, Regulatory Involvement

Majority of the SDARI study area was mapped using an object-based machine learning approach, leveraging Trimble eCognition software. The only areas not mapped using a machine learning approach were tidally influenced areas, which were mapping in eCognition using a ruleset-based approach developed through the Baylands Change Basemap project, also referred to as the Baylands Habitat Map 2020 effort (BCB https://www.sfei.org/projects/baylands-change-basemap , 2024). Data preparation, exploration, post-processing, and accuracy assessment work was done using ArcGIS Pro 3.1.3.

In 2021, the California State Water Resources Control Board and San Diego Regional Water Quality Control Boardfunded the creation of SDARI to provide a basemap for the San Diego Water Board Region. Under this funding SDARI will be incorporated into CARI and made publicly available through EcoAtlas.

Developed over the past two decades with initial regional development and demonstrations, and later applications statewide, the purpose of EcoAtlas has been to support the State Water Resources Control Board's Clean Water Act Section 401 – Certification and Wetlands Program, and the new *State Wetland Definition and Procedures for Discharges of Dredged or Fill Material to Waters of the State (Procedures)*. EcoAtlas' online geospatial platform employs CARI as the basemap for viewing and accessing other environmental datasets, mitigation and restoration project information, rapid condition assessment data, and other water quality monitoring data in order to support mitigation and restoration planning as well as tracking at local, regional, and statewide scales. The Landscape Profile tool, within EcoAtlas, can be used to interactively select a user-defined area from the CARI base map, and generate a profile of the amount, distribution, and diversity of streams and wetlands within the defined area. These geographic summaries help resource managers understand the status of aquatic resources when considering proposed

[1] The following standards were adapted from the Bay Area Aquatic Resources Inventory (BAARI) mapping standards and protocols for the use in the Sacramento - San Joaquin Delta, Delta Aquatic Resource Inventory (DARI).

impacts and mitigation projects. This guidance document provides details on SDARI methodologies and classification.

SDARI represents SFEI’s first primarily machine-learning based regional aquatic resource mapping project. However, this mapping effort builds upon science developed both internally and by other organizations. The classification system leverages decades of work, completed at SFEI, to establish meaningful speciation of aquatic resource classes to support California's WRAMP framework. It was also important to research what GIS layers and lidar derivatives have been helpful in other automated wetland probability and mapping efforts. These layers were combined in a unique way that through testing seemed to provide more accurate and desirable mapping outcomes in this particular landscape. While we didn’t apply other published models to this area in order to complete the mapping, it was particularly useful to utilized lidar-derived indices that are called out as being important in the Wetland Intrinsic Potential Tool (Halabisky, 2023) and ArcHydro Wetland Identification Model (WIM, 2018). Some classes, while still benefiting from an object based image analysis approach, were not classified using machine learning, but rather were mapped using rule based classification techniques. Tidally influenced habitats were both mapped using a rule-based methodology adapted from the BCB project. The rule based models for these classes were additionally informed by a USGS study on coastal wetland resilience (Thorne, 2018) in order to calibrate their tidal relative elevations using field-verified measurements . Vernal Pools were mapped within known vernal pool system areas also using a ruleset-based approach adapted from previous work within SFEI for Caltrans mapping individual vernal pools within existing California vernal pool system polygons.

SDARI Map Extent

The SDARI map extent is derived from the Water Quality Control Region 9 boundary in California (**Figure 1**), which covers approximately 2,484,350 US Survey Acres.

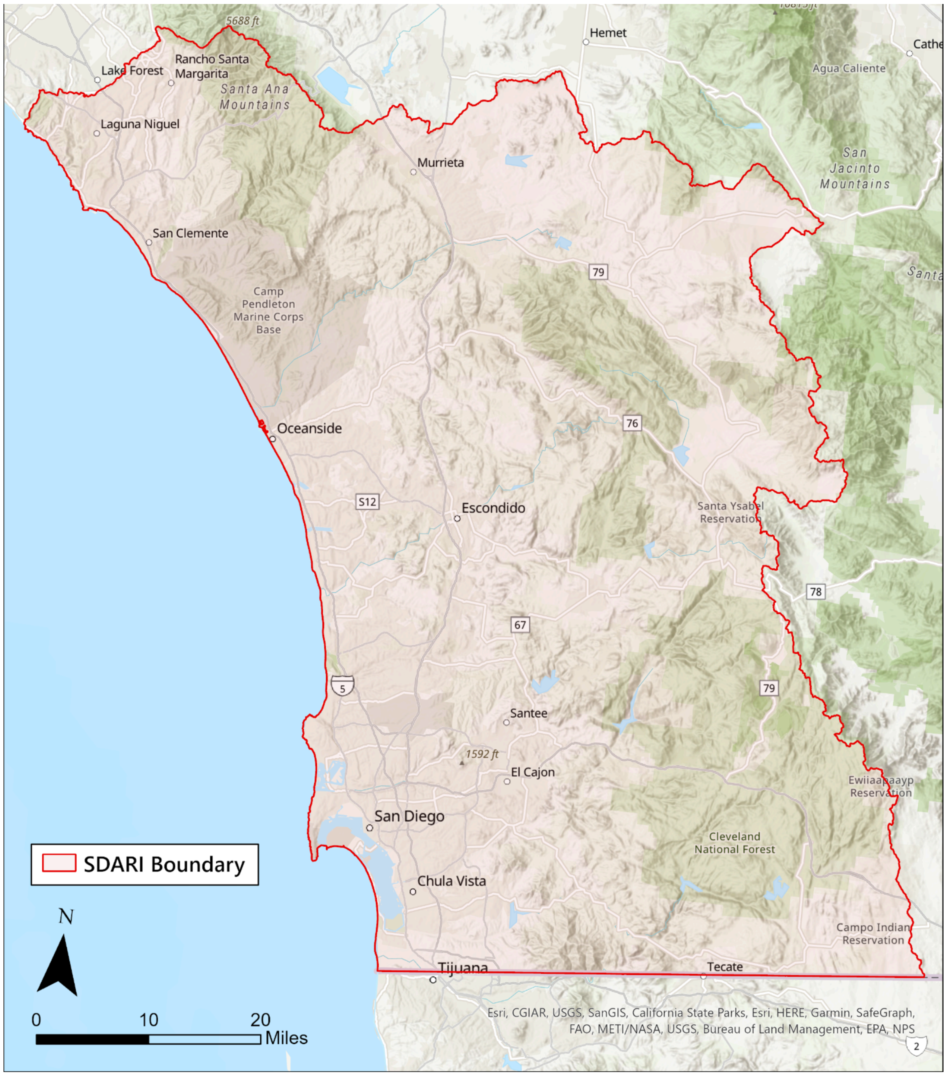

Figure 1. *Map of Water Quality Control Region 9 / SDARI map extent.*

2 SDARI Classification System

SDARI's aquatic feature classes were adopted from Bay Area Aquatic Resource Inventory (BAARI) and Delta Aquatic Resource Inventory (DARI) classification systems. It was adjusted to be inclusive of aquatic features types that occur in the Regional Water Quality Control Board Region 9's geographic extent, while remaining compatible with Statewide classification for the California Aquatic Resource Inventory (CARI). Channel features are mapped in a GIS as solely linear or linear and polygonal features depending on their channel widths. All other wetland types are mapped as polygonal features. The channel network is a line feature class that can be used for modeling and other purposes. It consists of line work that is mapped continuously through narrow and wide channels, and through other aquatic features (including reservoirs and lakes) by the addition of Artificial Paths through those open water features. The stream network also has Straler stream order added to it.

It is important to note that non-wetland riparian areas were not mapped within this dataset, however wetland riparian areas may be included in some of the polygonal classes described below (e.g. Tidal Vegetated Woody wetlands). Non wetland riparian areas are still defined later in section 2 in order to make the distinction of riparian areas that were mapped and those that were not mapped clear. Although beach, rocky shore, and dune habitat types have not been remapped within this effort, these habitat types were recently mapped along the coast by SFEI, funded by the Ocean Protection Council. These features are incorporated with SDARI mapping for the San Diego region in CARI.

Table 1 lists all the polygonal wetland types mapped in SDARI, using the wetland classification system described in section 2. The highest level of classification (Level 1) distinguishes between Tidal and Non-Tidal channels and wetlands. Most aquatic features in the SDARI study area are Non-Tidal. The second level (Level 2) groups aquatic features into channels (e.g. flowing ditches, streams, sloughs, etc., also known as riverine features) and other wetland types that are consistent with the state's Wetland and Riparian Area Monitoring Plan (WRAMP) framework[2] used for monitoring and assessing the amount, distribution, diversity, and condition of streams and wetlands at a watershed or other landscape scale (CWMW 2013).

To link between classification systems of the National Wetland Inventory (NWI) of the USFWS, and the statewide CARI dataset, crosswalks between SDARI and NWI and SDARI and CARI are presented in **Appendix A**.

Wetland Classes CARI v1.0 for study area SDARI Wetland Classes

Table 1. List of SDARI's Polygonal Aquatic Features.

Level 1	Level 2	Wetland Type Code	Wetland Type	Short Definition
Tidal	Channel	**TC**	Tidal Channel Natural	Tidally connected open water or dewatered channel
		TCU	Tidal Channel Unnatural	Tidally connected open water or dewatered channel with straightened planform
	Marsh	**TV**	Tidal Vegetated Natural	Generally Tule Marsh (can be pickleweed in Western Delta
	Lagoon	**TGPOWU**	Lagoon Perennial Open Water Unnatural	Large open water bodies with tidal connection
	Panne	**TP**	Tidal Marsh Panne Natural	Unvegetated ponds in marsh plain
	Flat	**TBF**	Tidal Flat	Unvegetated areas between MLLW and MTL
	Bay	**BD**	Bay Deep	Esturing areas deeper than 18 ft below MLLW
		BS	Bay Shallow	Esturing areas between 18 ft below MLLW and MLLW
Non-Tidal	Channel	**C**	Channel Natural	Sinuous channel inside a leveed island that not influenced by tidal action and sinuous fluvial channels above tidal range
		CU	Channel Unnatural	Straightened channels within leveed islands that are not influenced by tidal action and straightened fluvial channels above tidal range
		CV	Channel Vegetated Natural	Vegetated (herbaceous) portions of natural channels within leveed islands and fluvial

[2] For more information see: https://www.sfei.org/projects/statewide-wetland-tracking-science-and-policy-development-support

				channels above tidal range
		CVU	Channel Vegetated Unnatural	Vegetated (herbaceous) portions of unnatural channels within leveed islands and fluvial channels above tidal range
		CVw	Channel Vegetated Woody Natural	Willow Wetland (sometimes ash) portions of natural channels within leveed islands and fluvial channels above tidal range
		CVwU	Channel Vegetated Woody Unnatural	Willow Wetland (sometimes ash) portions of unnatural channels within leveed islands and fluvial channels above tidal range
		CE	Channel Engineered	Armored unnatural channels (Aqueduct)
	Depressional	**DOWN**	Depressional Open Water Natural	Small naturally impounded water bodies with no tidal connection
		DOWU	Depressional Open Water Unnatural	Small artificially impounded water bodies with no tidal connection
		DVN	Depressional Vegetated Natural	Vegetation adjacent to depressional open water
		DVU	Depressional Vegetated Unnatural	Vegetation adjacent to depressional open water
	Lacustrine	**LOWN**	Lacustrine Open Water Natural	Lake. Large water bodies >20 acres (8 ha) with no tidal connection. Historically present
		LOWU	Lacustrine Open Water Unnatural	Reservoir or Lake. Large water bodies with no tidal connection
		LVN	Lacustrine Vegetated Natural	Vegetation adjacent to lakes
		LVU	Lacustrine Vegetated Unnatural	Vegetation adjacent to lakes or reservoir34
	Slope	**FS**	Woody Slope Natural	Slope wetland larger than 0.5 acres (0.2 ha) with woody vegetation, usually Willows
		FSU	Woody Slope Unnatural	Slope wetland larger than 0.5 acres (0.2 ha) with woody vegetation. Most common example is along levees and wouldn't be present without a directly human modified environment.
		WM	Wet Meadow Natural	Slope wetland dominated by monocots or herbaceous vegetation
		WMU	Wet Meadow Slope Unnatural	Slope wetland dominated by monocots or herbaceous vegetation that forms due to unnatural landform
	Vernal Pool	**VP**	Vernal Pool	A special case of depressional wetlands with vernal pool endemic species
		VPC	Vernal Pool Complex	Multiple vernal pools, swales and the surrounding supporting adjacent non-wetland area

The Level 1 classification divides wetlands into two major categories: Tidal and Non-Tidal. In addition, wetlands can be further distinguished with vegetation, size and water depth, and anthropogenic modifiers. The remainder of this section characterizes SDARI's wetland types and their modifiers.

Tidal Wetlands (T)

The Tidal channels and wetlands consist of all the areas that are regularly influenced by tidal water movements. These fluctuations might be fully natural or muted due to tide gates, culverts, weirs, etc. Tidal channels can be saline, brackish, or completely freshwater and they exhibit tidal ebbs and flows because of the downstream influence of the tides. Within the Level 1 category of Tidal Wetlands we find the following Wetland Types:

Tidal Channels (TC)

Channels are a landscape feature with a well-defined bed and opposing banks that conveys water above ground at some point during the year. Tidal Channels are subject to tidal influence. Natural Tidal Channels(TC) are often sinuous, but can have slight modification (for example levees). Whereas Unnatural Tidal Channels (TCU) are usually much straighter.

Figure 2: *Tidal Channels (TCU and TC). The left image shows TCU, unnaturally formed Tidal Channels between salt ponds. The right image shows TC, Tidal Channels formed naturally and operating within natural ecosystem function.*

Lagoon (TG)

Lagoons are large impoundments of water, equal to or greater than 20 acres (8 ha), subject to muted tides or at least occasional or sporadic connection to full tidal action. Coastal lagoons or salt ponds may be smaller. Lagoons are generally open water (OW). Vegetation surrounding Tidal Lagoons are classified as Tidal Vegetated (TV). Lagoons can also be natural (N) or unnatural (U). Natural features can occur due to barrier beaches or dunes whereas unnatural features are often modified with levees with tide gates. Examples of lagoons that occur in the SDARI study area are managed salt ponds found in San Diego Bay.

Marsh (Tidal Vegetated) (TV)

Tidal Vegetated areas with greater than 10% vascular vegetation cover within a 100 m2 area. Tidal vegetation can occur in the form of discrete Tidal Marsh areas or as thin strips of vegetation (typically Schoenoplectus spp.) along shallow portions of Tidal Channels. Tidal marsh is a vegetated wetland that is subject to tidal action and has a suite of plant species that are dependent upon elevation and salinity. Tidal vegetated marsh occurs throughout portions of the SDARI study area within the tidal elevation frame, from the lowest extent of vascular vegetation to the elevation of the maximum observed high tide.

Tidal Marsh Panne (TP)

Tidal Marsh Pannes are areas that store surface water in Tidal wetlands during low tide. Marsh pannes are typical features of extensive, well-developed Tidal Marshes. The term refers to natural ponds that form in the marsh plain. These ponds, usually less than one foot in depth, fill with tidal water only during very high tides. They usually support less than 10% cover of vascular plant growth. They may be hypersaline in late summer, but they do not develop thick deposits of salts as do natural or commercial salt ponds. Most pannes are unvegetated, but some support wigeon grass and green macroalgae. There tend to be fewer but larger pannes in brackish marshes compared to salt marshes (Grossinger 1995).

Non-Tidal Wetlands (lack of "T" modifier)

Non-Tidal channels and wetlands consist of upland hydrogeomorphic wetlands,(e.g. riverine, slope, depressional wetlands) that are not influenced by the tides. These features have dominant water sources from groundwater, interflow, precipitation, overbank flow from channels, and lacustrine features.

Within this Level 1 category of Non-Tidal Wetlands we find the following Wetland Types:

Non-Tidal Channels (C)

Channels are a landscape feature with a well-defined bed and opposing banks that conveys surface water at some point during the year. The planform of natural channels has some amount of sinuosity, and typically flows in its original location, with only minor anthropogenic modifications to planform or location, whereas unnatural channels have been significantly modified, are usually much straighter, and may represent a shift from the original channel location or represent an entirely newly created channel. Areas of wider, mobile, unconstrained riverine systems may have wider active channels that include forested riverine features that are included in riverine/channel category. However, as this project does not aim to map riparian areas, which is a zone that includes both wetland and non wetland habitat features, polygons in this type of channel are mapped to include the open water and sandy, recently mobile portions of channels, and vegetated portions within the wider channel banks that are periodically inundated by fluvial waters.

Depressional Wetlands (D)

Depressional Wetlands are features that form in topographic lows. If the depression is connected to surface drainage, the flow is not enough to create an obvious current of water through the depression, except perhaps during extreme high-water events. Depressional wetlands have a minimum size of 0.025 acres (100 m^2). They can have prominent areas of perennial or seasonally open water (OW) and areas of adjacent vegetation (V). These features can be natural (N) or unnatural (U). The open water areas can include non-vegetated areas that are seasonally flooded and do not support more than 10% vegetation. The open water portion differs from that of lacustrine wetlands by being smaller than 20 acres (8 ha) in area and having an average depth less than 6 feet (2 m) during the dry season. The vegetated portion can support woody wetland vegetation (e.g., willows, cottonwoods,alders or ash) and herbaceous wetland plants (e.g., sedges,rushes, grasses), and does not have an upper size limit.

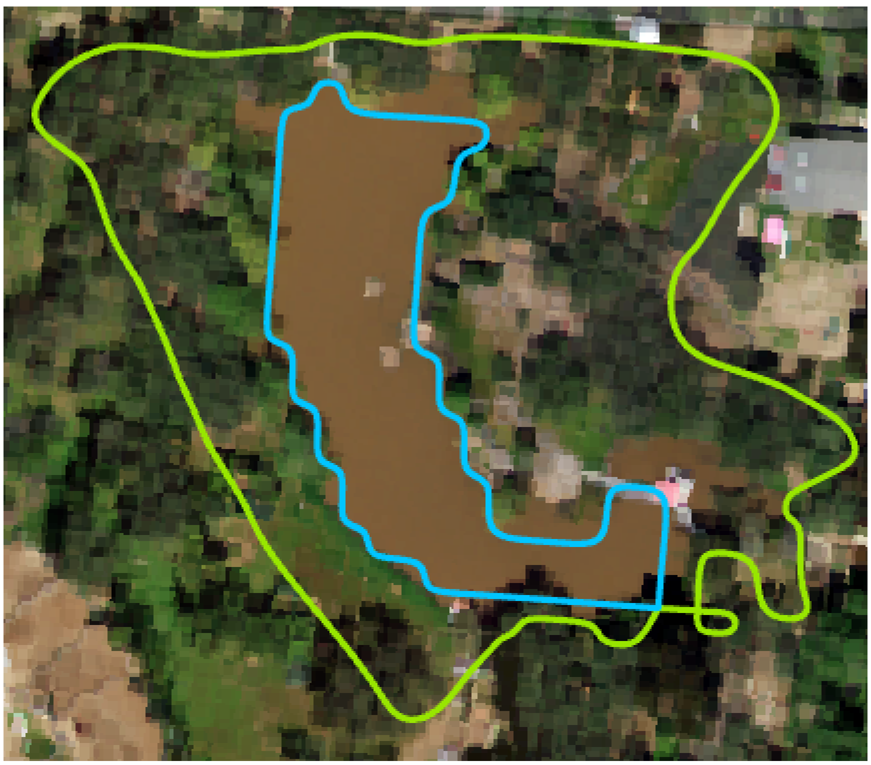

Figure 3: *Depressional wetland (DOWN surrounded by DVN).*

Lacustrine Wetlands (L)

Lacustrine Wetlands are wetlands with areas of open water equal to or greater than 20 acres (8 ha). Natural lacustrine features are commonly called lakes: i.e., they lack dams or other man-made structures that are responsible for creating the open water areas. Unnatural lacustrine features are impoundments behind dams or other manmade structures and are commonly called reservoirs. Lakes tend to vary less in size within and between years than reservoirs, which tend to expand and contract in area due to water management. Lacustrine features have an average depth of at least 6 ft (2 m) during the dry season. They are always comprised of two parts: the area of open water (OW) and the area of wetland vegetation (V) that borders the open water area. This vegetated area does not have an upper size limit—it simply must be hydrologically dependent on the open water feature. Any wetland areas of a reservoir are classified as unnatural due to the influence of the unnatural impoundment. Lacustrine wetlands can adjoin other wetlands, such as slope wetlands and riverine wetlands.

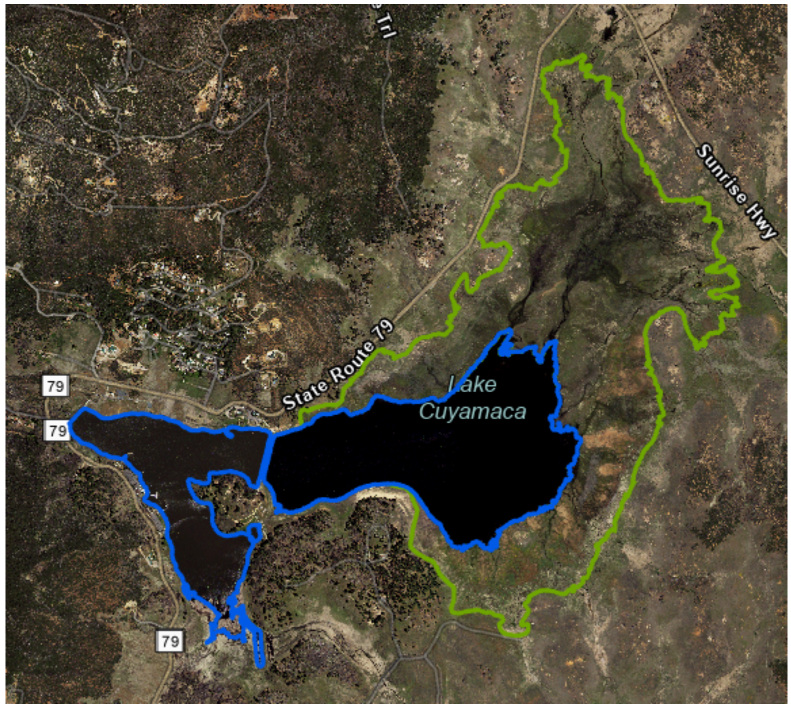

Figure 4. *Lacustrine open water areas in a reservoir, an unnatural lacustrine feature (LOWU), and adjoining lacustrine vegetated wetlands (LVU).*

Woody Slope Wetland (FS)

Woody Slope Wetlands are slope wetlands larger than 0.5 acres (0.2 ha) that form due to a seasonal or perennial emergence of groundwater into the root zone and in some cases onto the ground surface across a larger area than a seep or spring. The ground surface in these wetland locations typically have a very gentle slope or essentially no slope. Woody Slope Wetlands also support more than 30% cover of tall woody vegetation (e.g. willows or ash trees), as evidenced in aerial imagery, or any available vegetation dataset. These wetlands can adjoin non-forested slope wetlands (i.e., wet meadows). Woody Slope Wetlands can also include wetland areas with less than 30% woody cover (i.e., non-forested slope wetlands) that are not larger than 0.5 acres (0.2 ha). An example of a woody slope wetland is an area on the gentle slope extending from a flat field down to the adjacent channel that is dominated by sandbar willow (Salix exigua).

Non-woody Slope Wetlands (Wet Meadow) (WM)

Non-woody Slope Wetland, or Wet Meadow, features are groundwater-fed wetlands that exist in gently sloped or flat topography. They are similar to woody slope wetlands, in that groundwater feeds the root zone of the wetland vegetation, except they lack the woody vegetation species cover. These areas are found across the Delta, including on slopes that are adjacent to other wetland types or in broad, flat wetland plains. They can also be found in farmed areas where wetland plants or bare soil exist due to persistent emerging groundwater. WM features in farmed areas are only mapped if they have not been farmed in two or more image years, although those years do not have to be consecutive.

Figure 5. *Wet Meadow (WM).*

Vernal Pools

Vernal pools are a special kind of seasonal depressional wetland having a shallow subsurface bedrock or impervious soil horizon that prevents the surface water from infiltrating, and that support a unique suite of vernal pool endemic floral species. These depressions fill with rainwater and runoff from small catchment areas during the winter and may remain inundated until spring or early summer, sometimes filling and drying repeatedly during the wet season. Vernal pools often occur together with vernal swales as vernal pool systems (or complexes) that have many pools of various sizes and shapes, varying floral and faunal composition, and varying hydroperiods. Water can move between adjacent pools and swales via surface water flow or via shallow subsurface flow through the thin soils above the underlying impervious substrate.

SDARI mapped individual vernal pools only in known system areas with high resolution lidar, which includes vernal pool systems highlighted in either CARI version 2.2 or the California Department of Fish and Wildlife (CDFW) Vernal Pools ds2732. Additional vernal pool systems were identified manually through expertise provided by the RB9 staff.

Individual Vernal Pools (VP)

Individual vernal pools (VP) are mapped when an individual pool is discernible in the imagery and lidar. Individual pools were not comprehensively delineated, and only mapped in known systems due to limitations of data resolution and availability throughout the study area.

Figure 6. *Individual Vernal Pool (VP).*

Non-Wetland Riparian Areas (not mapped)

Non-wetland riparian areas are not mapped in SDARI. A riparian area is an area through which physical and biological processes interconnect aquatic or wetland areas to their adjacent terrestrial areas. Riparian areas are distinguished by gradients in biophysical conditions, ecological processes, and biota. They can include terrestrial areas that measurably influence, or that are influenced by, the conditions or processes of the aquatic or wetlands areas. For any given form and structure of a riparian area, its width depends on its function. (California Wetland and Riparian Area Protection Policy TAT. Technical Memorandum No 5: Stream Definition. Version 2. April 20, 2016).

In addition, the National Research Council (2002) riparian definition includes "areas through which surface and subsurface hydrology connect water bodies with their adjacent uplands".

What is often considered to be riparian areas often include, but are not limited to, woody slope wetlands, adjacent to channels, that are forested with trees. These features may be related to, but are distinct from forested channels (vegetated woody channels).

Although there may be wetlands mapped that fall within a chanel's associated riparian areas, the full extent of riparian areas are not mapped in SDARI because not all riparian areas meet the definition of being a wetland. That is, there are riparian areas that do not meet the three wetland criteria of: the presence of wetland soils, saturation for a period of time, or supporting wetland plant species. These riparian areas that do not meet the definitions of being a wetland are not mapped in this aquatic resource inventory. However, as described above, these areas are closely associated with wetlands. Every wetland has an associated riparian area. Riparian areas start where the wetland stops; the two areas share a common boundary. The riparian area extends outward, or away from the wetland feature. The width of a riparian area is variable, and will depend upon a number of factors including topography, type of associated wetland feature, land use, and moisture gradient. Some areas are quite wide, while others can be very narrow (1m or less). While riparian areas are typically thought of as supporting woody vegetation, riparian vegetation can also consist of herbaceous and grassy vegetation as well.

SFEI has developed a tool to help model estimated Riparian Functional With called the Riparian Zonal Estimation Tool (RipZET) (www.sfei.org/projects/ripzet). RipZET works within a Geographic Information System (GIS) to estimate the likely extent of riparian areas based on the concept of "functional riparian width." According to this concept, different riparian functions can extend different distances from their adjacent surface waters, depending on topographic slope, vegetation, land use, and position along a drainage network. RipZET translates this concept into estimates of riparian width for selected riparian functions, and the tool is modular so that new functions can be added as needed. RipZET provides reach-scale estimates of the riparian width associated with the relevant riparian functions (e.g., large woody debris supply in wetlands and in headwater channels or floodwater storage in low-gradient alluvial channels). RipZET was not run in conjunction with the creation of SDARI.

Wetland Modifiers

For many Wetland Types there are several modifying wetland descriptors which provide additional information about the wetland feature. These modifiers are included in the wetland classification system and described below. The full list of all unique Wetland Type combinations mapped in SDARI (including these modifiers) is provided in **Tables 1 and 2** at the beginning of Section 2.

Open Water (OW) and Vegetated Areas (V)

Many wetlands consist of two basic elements: an open water area and a vegetated area. Open water areas (OW) are at least 90% percent open water using a 100 m^2 search area, meaning they have less than 10% vegetative cover. Vegetated areas (V) therefore have at least 10% vegetation cover. The code Non-vegetated (U) is only used for wetlands that fit the wetland definition of *playas* and should not be confused with the unnatural wetland modifier of the same code (U, see below). For example, “PUU” refers to “Playa Non-vegetated Unnatural”). These non-vegetated playas are areas without standing water during the dry season, less than 10% vegetation cover. All three types (OW, V, U) can be natural (N) or unnatural/man-made (U), see below.

Woody (w)

Descriptor added to a vegetated wetland area that is wooded (typically comprised of willow but can include other woody species such as ash, cottonwood, and alder). Per definitions of woody habitats in CRAM, a threshold of 30% woody vegetation coverage was used to assign the woody modifier.

Natural (N) or Unnatural (U) Wetlands

Natural wetlands owe most of their existing form and structure to natural processes. They might have been created, restored, enhanced, or otherwise modified by the direct or indirect actions of people, and they might be actively protected or otherwise managed. However, the natural processes of geology and climate largely control their character, including their shape, size, location, sediment characteristics, hydrology, chemistry, and biology. Unnatural wetlands do not meet these criteria; for example, a stock pond or drainage ditch. Further, if the open water area of a wetland is unnatural, then all the associated vegetated area(s) is also considered unnatural.

Deciding whether a wetland area is natural or not requires careful consideration of its apparent form, structure, and hydrological regime, relative to what is expected based on an expert understanding of the likely controlling factors and processes. For any mapping effort, such considerations will evolve into a set of guiding “rules of thumb” that must be applied consistently throughout the mapping effort. Different practitioners must be able to use the same rules in the same way to produce comparable maps. Initial determinations of what is natural might have to be revised as experience is gained. Some rules governing the designation of areas as natural or unnatural are generally applicable.

Deep (d) vs Shallow (s)

Distinguishing between deep vs shallow does not require manual mapping. This distinction was made using a MLLW raster.

For Bay Shallow / Bay Deep polygon features, 12ft below MLLW was used as the cutoff between shallow and deep bay. While it is difficult to define an exact depth at which the cutoff between shallow and deep water occurs, this cutoff value is consistent with a number of sources listed below:

- The San Francisco Bay Adaptation Atlas (SFEI & SPUR 2019: 26-27). Based on the approximate depth where “resuspension of sediments by wind-driven waves” occurs

- The approach being considered by Wetlands Regional Monitoring Program (WRMP)

Shallow Depths (<12ft below MLLW) are also inclusive of:

- The depth at which we no longer find persistent submerged aquatic vegetation (SAV) (~ 10 ft/3m, with most attenuation shallower than ~6.6ft/2m) (personal communication with Shruti Khanna)

3 Target Mapping Unit (Tmu)

The target mapping unit (Tmu) is a desired minimum mapping unit for developing SDARI. The goal is to maximize the detail of the dataset, capturing small yet important habitats (e.g. seeps) while producing a consistent dataset for the region.

- The Tmu for most aquatic polygonal features is 0.025 acres (100 sq m).
- *Lacustrine Open Water wetlands* (LOWN or LOWU) have a Tmu of 20 acres (~81,000 sq m).
- *Natural channels* (C) have a Tmu length of 50m.
- *Unnatural channels* (CU) (e.g. ditches), engineered (CE) and subsurface channels (CSD), have a Tmu length of 25m.
- *Any channel* that connects a water body to another wetland feature has no Tmu. For example, a channel that can be used to drain an unnatural depression will have no Tmu.

4 Projection and Datum

All SDARI data, at all stages of mapping, are maintained in the NAD 1983 UTM Zone 11N. This dataset will be reprojected and merged with the other CARI datasets which is projected in California Teale Albers, NAD 1983.

5 Data Sources

NAIP 2020 imagery, Sentinel-2 imagery, LiDAR-derived digital elevation models (DEMs) and derivatives, and tidal datum data were the data sources input into our machine learning model to map SDARI. Additional ancillary data sources were used to refine the classification in post-processing, but were not input into the model.

Primary Mapping Data Sources

Imagery

National Agriculture Imagery Program (NAIP)

The National Agriculture Imagery Program's (NAIP, 2020) aerial imagery, available through the US Department of Agriculture (USDA, http://www.fsa.usda.gov/FSA/) and downloaded in October 2022, covers the full extent of the SDARI area of the interest, the Water Quality Control Region 9 boundary. It was downloaded at its original spatial and spectral resolution, consisting of 4 band, natural true color and infrared imagery at a 1m pixel resolution, and georectified to the national standards at a 1:24,000 scale. These digital aerial imagery capture leaf-on conditions. NAIP was represented in our machine learning model by two spectral indices derived from the original 4 band data, Normalized Difference Vegetation Index (NDVI) and Normalized Difference Water Index (NDWI).

The choice to use NAIP was based on precedent, spatial coverage, year flown, data availability, and uniquely high resolution. NAIP imagery is publicly available without cost from the USDA and covers the entire state of California, which is important for incorporating SDARI into the statewide CARI dataset, and when transferring the mapping standards to other parts of the state. NAIP datasets are flown periodically for California which helps ensure the aquatic resources inventory can be updated.

Sentinel-2

SDARI make use of Sentinel-2 data, made publicly available for free by the European Space Agency (ESA, https://www.esa.int/) as part of their Copernicus earth observation program. Sentinel-2 data has a 10 day revisit time, 13 bands, and 10m spatial resolution. Due to its high temporal resolution, using Sentinel-2 to supplement NAIP allowed vegetation phenology to be incorporated into the machine learning model. The imagery was downloaded from Google Earth Engine (GEE) in February 2024 as 12 monthly mosaics taken in 2020, with imagery from 2021 filling in gaps due to high cloud coverage. Each monthly composite was then transformed into NDVI and incorporated into a 12-band Principal Components Analysis (PCA) to represent wetland phenology in the SDARI model. Band 3 of the PCA was used as input in the final machine learning model.

Elevation

USGS 3d Elevation Program

Lidar from the USGS 3d Elevation Program (USGS 3DEP, https://www.usgs.gov/3d-elevation-program/) significantly contributed to the SDARI model. There is not one lidar dataset with full coverage for the SDARI study area. Consequently, a combination of 1m resolution 3DEP lidar projects throughout the years 2014 - 2018 were mosaicked for coverage of the study area. Additional lower resolution DEMs filled in the limited gaps in lidar coverage, mainly located in the northern reaches of the study area (see figure 9). Lidar data used includes the 2014 Western San Diego County, 2015 Central San Diego County, 2016 Eastern San Diego County, and 2018 Southern California Wildfire lidar projects. The lidar was downloaded as Digital Elevation Models (DEMs) and later transformed into a set of lidar derivatives for both input into the machine learning model and for post-processing steps.

Lidar data was incorporated into the SDARI machine learning model as derivatives, including geomorphons, geomorphons range, depth to water (DTW) index, slope, and fill difference. The Geomorphon Landforms tool was parameterized with a 20m search distance, 0m skip distance, and a 1 degree flat angle threshold to capture fine-scale geomorphology and a speckled signature for wetland features. The geomorphons range was beneficial as wetland features showed high range from dense speckling of values from 1-10, and was calculated in a 5x5 cell search window. DTW was created using the Depth to Water tool in ArcHydro and streams sourced from CARI. Additionally, flow accumulation and a Canopy Height Model (CHM) were used for post-processing classification but not incorporated into the machine learning model.

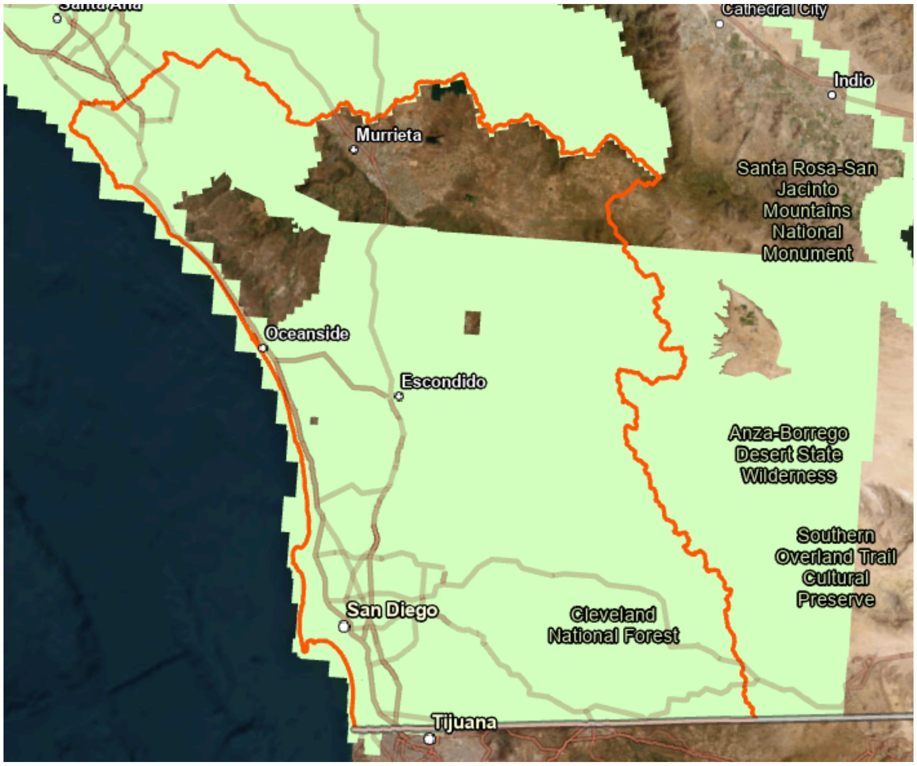

Figure 7. *High resolution lidar coverage is shown in light green, with the SDARI study area boundary shown in orange. Areas not covered by the light green and showing the underlying imagery are where supplementary lower resolution lidar was used. Approximately 450,500 acres, or 18%, of the SDARI study area didn't have high resolution lidar available at the time of mapping.*

Secondary and Ancillary Data Sources

Secondary data include additional datasets not used in the machine learning model that helped refine the SDARI classification after machine learning. These data were used to refine the initial wetland classification and object extent post-machine learning through thresholding in eCognition.

The following datasets were used for post-processing in SDARI:

- C-CAP (CCAP 2019-2021)
- Vernal Pools ds2732 (CDFW, 2020)
- Microsoft Buildings Footprints (Microsoft, 2018)
- i15 Crop Mapping (DWR, 2019)
- i17 California Jurisdictional Dams (DWR, 2018)
- Riverside County Land Use (Riverside County, 2016)
- Orange County Land Use (SCAG, 2016)
- San Diego County Land Use (SanGIS, 2017)
- California Coastal Confluence Inventory (CCWG, 2013)
- CalVeg (USFS, 2018)

- VegCamp (CDFW, 1998-2021)
- FVeg (CALFIRE, 2015)

Each dataset is described below.

C-CAP Percent Impervious (NOAA, 2019-2021). The NOAA Coastal Change Analysis Program (C-CAP) produces national-scale high resolution (1m-2.4m) land cover raster data in all coastal and great lakes states. This data was downloaded from NOAA's Digital Coast C-CAP High Resolution Landcover portal and was 1m in resolution throughout the RB9 study area. Per the use restrictions on the C-CAP data, this data was not used in the machine learning process for SDARI. Rather, the C-CAP Impervious and Canopy Cover datasets were used post-processing to characterize the vegetation and anthropogenic modifiers. The C-CAP Canopy Cover layer was only used in areas without high resolution lidar, and the Impervious layer was used throughout the study area.

The dataset can be accessed here: https://coast.noaa.gov/digitalcoast/data/ccaphighres.html

Vernal Pools ds2732 (CDFW, 2020). This dataset was sourced from the CDFW Biogeographic Information and Observation (BIOS) portal. DS2732 divides the state of California up into hexagons approximately 2,260 acres in area and indicates with a "Y" or "N" whether there is another CDFW vernal pool dataset that intersects the hexagon and specifies the dataset by its CDFW "ds" ID. Most of the additional datasets pointed to by ds2732 were not publicly available, however the "Y" hexagons were still used to indicate the potential presence of vernal pool systems. High resolution lidar data was used to confirm the presence of vernal pools within the hexagons.

The dataset can be accessed here: https://apps.wildlife.ca.gov/bios6/

Microsoft Building Footprints (Microsoft, 2018). The Microsoft Building Footprints dataset was accessed using ArcGIS Online (AGOL) and shows a comprehensive map of buildings across the United States produced through deep learning. Building footprints were used to refine object shapes, avoid mapping urban features, and assist with characterizing the anthropogenic modifier.

The dataset can be accessed here:
https://hub.arcgis.com/datasets/esri::microsoft-building-footprints-features/about

i15 Crop Mapping (DWR, 2019). The i15 Crop Mapping dataset, developed by Land IQ for the California Department of Water Resources (DWR), offers a comprehensive spatial database mapping and classifying crops for the 2019 water year, focusing on irrigated agriculture and urban areas in California. 2019 was selected as it was the most recent year mapped at the time SDARI was produced. This dataset was used to help refine overmapped wetland shapes and remove crops wrongly identified as wetlands. Additionally, this dataset was used to help identify stock ponds and other unnatural agricultural open water features in the anthropogenic modifier.

The dataset can be accessed here: https://lab.data.ca.gov/dataset/i15-crop-mapping-2019

i17 California Jurisdictional Dams (DWR, 2018). This dataset provides detailed point data on dams under the jurisdiction of DWR Division of Safety of Dams. This dataset was used in post-processing to help identify and attribute unnatural lacustrine and depressional features with the anthropogenic modifier.

The dataset can be accessed here: https://gis.data.ca.gov/datasets/98a09bec89c84681ae1701a2eb62f599/explore

Riverside County Land Use (Riverside County, 2016). Riverside County produced a comprehensive polygonal land use dataset with a detailed classification schema. This dataset was used in post-processing to identify unnatural wetland features in the anthropogenic modifier, particularly within golf courses.

The dataset can be accessed here: https://gisopendata-countyofriverside.opendata.arcgis.com/datasets/CountyofRiverside::general-plan-landuse/about

Orange County Land Use (SCAG, 2016). The Southern California Association of Governments (SCAG) developed a detailed 2016 land use dataset for Final Connect SoCal, a 2020-2045 Regional Transportation Plan. This dataset was used in post-processing to identify unnatural wetland features in the anthropogenic modifier, particularly within golf courses.

The dataset can be accessed here: https://hub.scag.ca.gov/datasets/2db3558d212d42e5b64cd136ffe0467f_0/explore

San Diego County Land Use (SANGIS, 2017). The San Diego Geographic Information Source (SANGIS) produced a detailed polygonal land use dataset from 2017 imagery. This dataset was used in post-processing to identify unnatural wetland features in the anthropogenic modifier, particularly within golf courses.

The dataset can be accessed here: https://sdgis-sandag.opendata.arcgis.com/maps/6fed6288eac2420aab91e337720d69bd/about

California Coastal Confluence Inventory (CCWG, 2013). In 2013, the Central Coast Wetlands Group (CCWG) published a paper describing methods for identifying bar-built estuaries on the California Coast. The resulting point dataset, which identifies bar-built estuaries down the entire coast of California, was used in SDARI to indicate bar-built tidal features in the Subtype modifier.

CALVEG South Coast (USFS, 2018). The CALVEG South Coast dataset is part of the CALVEG (Classification and Assessment with LANDSAT of Visible Ecological Groupings) mapping initiative, covering the northeastern part of CALVEG Zone 7, the South Coast. This polygon layer, with source imagery from 2002 to 2010 mapped in 2018, employs the CALVEG classification system for vegetation typing. This dataset was merged with other vegetation mapping projects to comprehensively cover the SDARI study area. CALVEG was not used in the mapping of SDARI, however it was referenced during the accuracy assessment to help reviewers with their classification.

The dataset can be accessed here: https://data.fs.usda.gov/geodata/edw/datasets.php?xmlKeyword=calveg

VegCamp (CDFW, 1998 - 2021). The Vegetation Classification and Mapping Program (VegCAMP) is a CDFW program mapping and classifying vegetation according to the National Vegetation

Classification System. It focuses on high-priority conservation and management areas for assessment and mapping projects, supports training programs, and works on best practices for field assessment, vegetation data classification, fine-scale mapping, and data archiving. This dataset was merged with other vegetation mapping projects to comprehensively cover the SDARI study area. The follow VegCamp datasets were incorporated into the vegetation compilation:

- Anza-Borrego SP (1998)
- Naval Weapons Station Seal Beach Detachment Fallbrook (2021)
- Oak Grove (2012)
- Orange County (2015)
- San Felipe WLA (2005)
- Western Riverside County (2005)
- Western Riverside County Remap (2015)
- Western San Diego County (2012)

VegCamp was not used in the mapping of SDARI, however it was referenced during the accuracy assessment to help reviewers with their classification.

The dataset can be accessed here: https://wildlife.ca.gov/Data/VegCAMP/Background

FVeg (CALFIRE, 2015). FVeg, developed by CALFIRE's Fire and Resource Assessment Program (FRAP) in collaboration with CDFW's VegCamp program and the USFS, compiles the best available land cover data across California into a comprehensive set. This dataset, which spans from 1990 to 2014, is designed to accurately depict habitat types within California for various government functions, using a common classification scheme based on the California Wildlife Habitat Relationships (CWHR) system. This dataset was merged with other vegetation mapping projects to comprehensively cover the SDARI study area. FVeg was not used in the mapping of SDARI, however it was referenced during the accuracy assessment to help reviewers with their classification.

The dataset can be accessed here: https://map.dfg.ca.gov/metadata/ds1327.html

6 SDARI Geodatabase Schema

Table 2. The final SDARI geodatabase schema includes the following fields.

Field	**Notes**
OBJECTID	Unique numeric ID assigned to each feature
Shape	Required field specifying the type of feature geometry
Wetland_Type	SDARI wetland class
Level1	Specifies feature's tidal regime
Level2	Major classification of the wetland classification provided
CARI_clickcode	SDARI Wetland_Type crosswalked to the CARI classification schema

anthropogenic_modifier	Classification that indicates if the aquatic feature's physical structure has been significantly impacted by anthropogenic activities.
Subtype	Wetland type that provides additional wetland classification speciation in the context of the wetland_class
Vegetation	Indicates the dominant type of vegetation for an aquatic feature

7 Mapping Procedures

Data Collection and Preprocessing

Wetland habitats in southern California are diverse in their presentation, geomorphology, phenology, and appearance. Consequently, the goal of data collection and preprocessing was to have a diverse collection of raster and vector inputs to be able to differentiate the diversity of the SDARI habitat classes.

High resolution lidar data and its derivatives were critical inputs to the SDARI model. Lidar ranging from 0.7m - 1m resolution was downloaded from the USGS 3DEP program where available, making up approximately 82% of the study area. Lower-resolution data was used in gap areas. Ultimately, the five different lidar projects were first resampled to 1m, when necessary, using "Nearest Neighbor" for upsampling the lower-resolution data and "Bilinear" for downsampling the 0.7m resolution data. Finally, the lidar data was mosaicked into a seamless 1m DEM with coverage for the entire SDARI study area. Ideally there would be full coverage of 1m or higher resolution lidar data available. It's important to note that gaps in licar coverage should be covered in the coming years from reported lidar collection projects. Lidar derivatives were produced for the entire study area and included:

- Flow Accumulation
- Fill Difference
- Geomorphon Landforms
- Depth to Water (DTW)
- Slope
- Geomorphon Landforms Range

Flow Accumulation and Fill Difference were created using default parameters. Flow Accumulation was useful in post-processing to differentiate between Channels vs other types of open water, and Fill Difference was used to identify depressional and lacustrine wetlands. Slope was created using the recently released ArcGIS Pro "Surface Parameters" tool and expressed as percent rise - this layer helped identify wet meadows and forested slopes. Geomorphon Landforms were parameterized with a search window of 20m, a skip distance of 0m, and a flat angle threshold of 1. With this parameterization, wetland features and vernal pools yielded distinct speckled and dimpled spectral signatures which helped in identifying potential wetland locations.

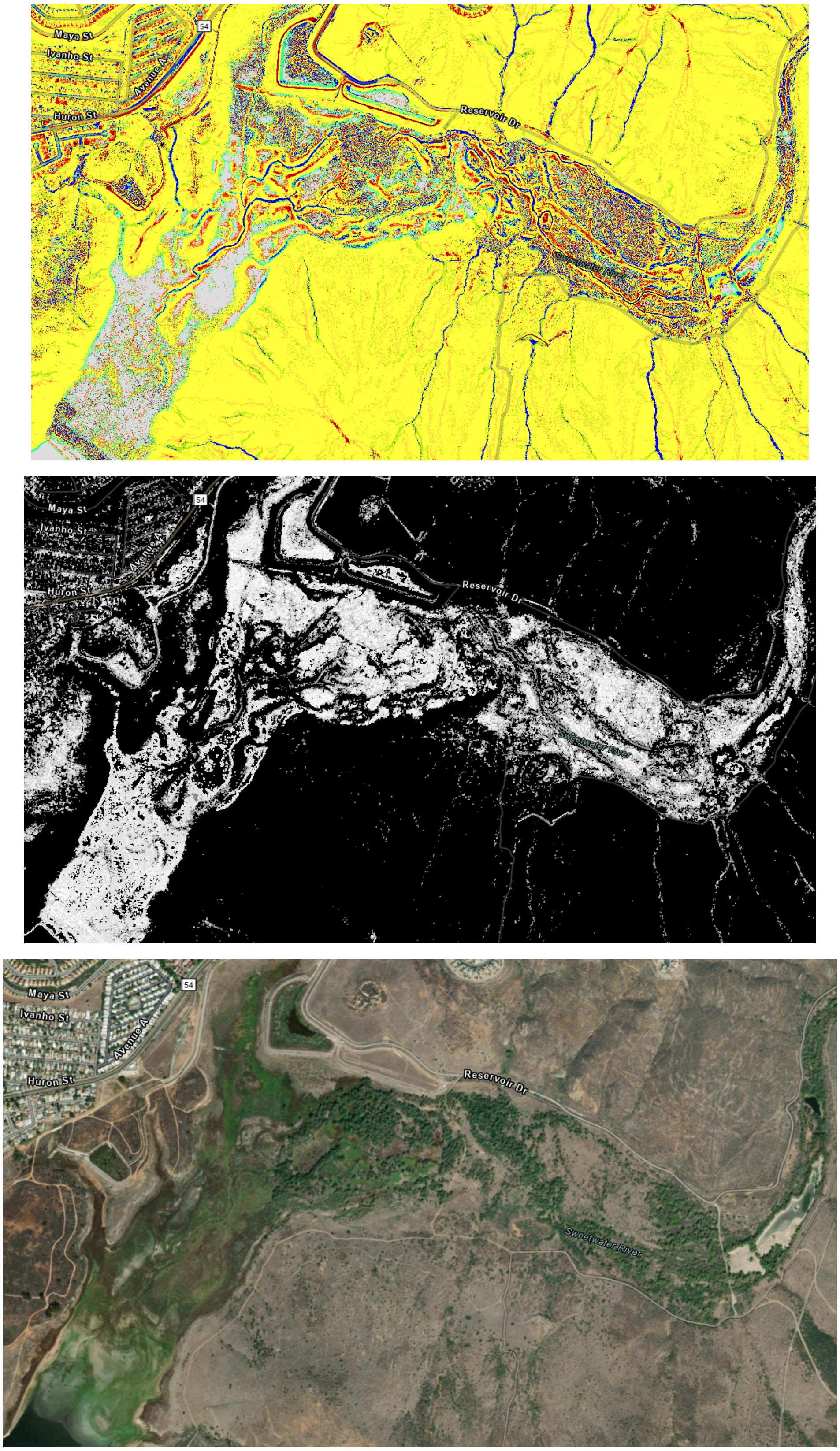

Figure 8. *Geomorphon Landforms, shown in the topmost image, show significant speckling in potential wetland areas. Geomorphon Landform range values were higher in these speckled areas, as seen in the center image.*

Due to the speckling of values in potential wetland areas, range was determined to be a useful statistic as regions with a high range of landform values were often wetland features. Range calculated on a 5x5 pixel window on the Geomorphon Landforms raster using Focal Statistics. The final lidar derivative used was DTW, which was used to help identify large mobile channels in the SDARI study area. DTW was parameterized with a resampled 10m resolution version of the SDARI DEM to prevent speckling as well as NHD flowlines filtered to preserve large channels. Smaller-order streams and other open water features such as ponds and lakes were excluded to prevent misidentification of wetlands in low-terrain urban areas.

Imagery was another significant contributor to the SDARI model and was sourced from NAIP and Sentinel-2. Although NAIP is available at resolutions higher than 1m, the 1m data was chosen to help improve processing time across the large study area. 2020 NAIP was downloaded from Google Earth Engine (GEE) and mosaicked for the entire SDARI study area. NAIP was used in the machine learning model by leveraging NDVI and NDWI indices, which were calculated and rescaled in eCognition. Sentinel-2 data was also downloaded from GEE as 12 monthly composites from the year 2020. 2021 imagery was used to fill in gaps in 2020 data due to significant cloud coverage. NDVI rasters were created for each monthly composite in ArcGIS Pro, followed by a 12-band Principal Components Analysis (PCA) on the NDVI rasters. There were interesting insights in each of the PCA bands, however band 3 was the only data used as it highlighted Wet Meadow (WM) and Forested Slopes (FS) well.

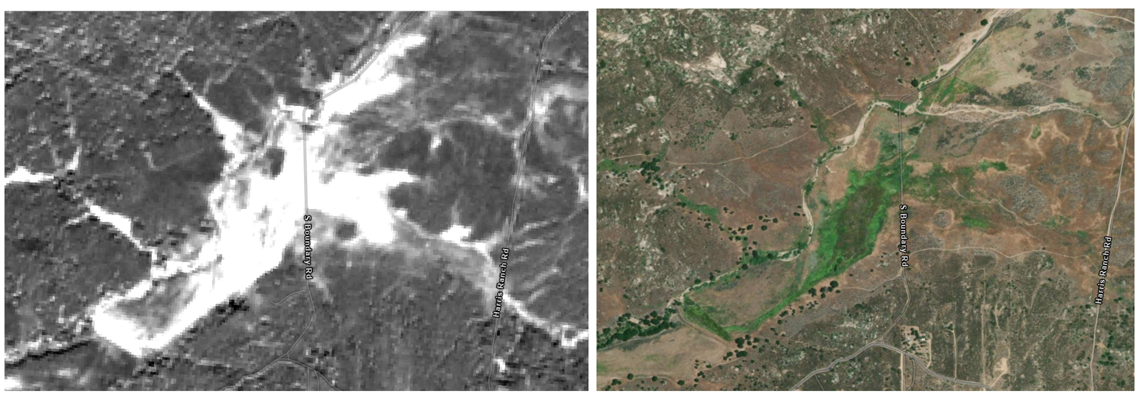

Figure 9. *The Sentinel-2 PCA Band 3 is shown on the lefthand side, yielding high values in wet meadow areas like the one shown in the right image.*

The SDARI raster inputs represented a diversity in the domain of values for each dataset, with layers like NDVI ranging from [-1,1] compared to the Sentinel-2 data ranging from [0,15000]. Thus, each raster input was rescaled to a [0,255] range using the Rescaled by Function tool in ArcGIS Pro. The only exception to this was the NAIP NDVI and NDWI, which were created and rescaled in eCognition. The function used to rescale each input was different and depended on what segment of values within each domain were useful to highlight more. For example, higher values in the Sentinel-2 PCA were related to WM and FS classes, so the Logistic Growth function was used to improve the contrast between high and low PCA values.

Training data was generated as 1,500 points across the SDARI study area and was a combination of points dropped by scientists with local expertise using lidar and imagery and field work. The data collected from the field work can be seen in Appendix C. Classes included in the training data were Open Water, Depressional Wetland, Slope Wetland, Urban, and Other Vegetated.

Finally, the vector datasets described in the ancillary datasets were merged to the entire SDARI study area where relevant. All data was projected to NAD 1983 UTM Zone 11N and then clipped to each HUC10 within the SDARI study area as a way to segment processing.

Analysis in eCognition

Data was processed by HUC10 and imported into eCognition using the Customized Import functionality. This ultimately resulted in 34 HUCs being imported in eCognition. Processing in eCognition is determined through a ruleset, which is pictured below. The SDARI ruleset was broken out by processing steps. Many of the ruleset decisions made in SDARI were made to optimize for processing time and software availability, consequently speed and efficiency was prioritized when necessary for choosing segmentation algorithms, machine learning algorithms, etc.

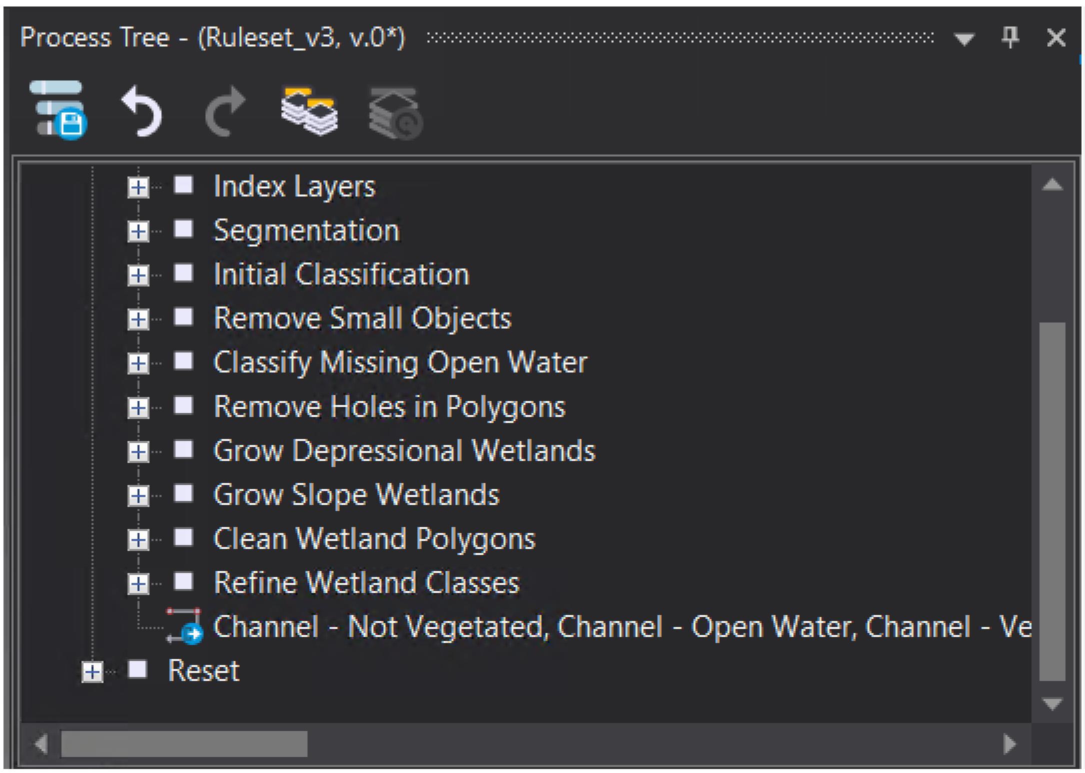

Figure 10. *The SDARI ruleset open in eCognition.*

The "Index Layers" section of the ruleset generates and rescales the NAIP NDWI and NDVI, as mentioned above. In future automated wetland mapping projects, SFEI would aim to generate and rescale these derivatives in ArcGIS Pro to add more nuance to the rescaling process. To minimize processing time across a large study area, our initial segmentation, outlined in the "Segmentation" portion of the ruleset, was a Chessboard Segmentation set to 3 pixels. The Merge Region algorithm was used to create larger objects based on NDWI and Fill Difference, creating larger continuous features for open water and depressional features.

The “Initial Classification” step of the process imports the training data as a CSV, trains a Random Forest classifier with 100 trees, and applies the classifier to the input layers. The layers input to the Random Forest classifier include:

- NAIP NDVI
- NAIP NDWI
- Sentinel-2 NDVI PCA Band 3
- Geomorphons
- Geomorphons Range
- DTW
- Slope
- Fill Difference

The Random Forest classifier output broad classes which are later refined in the ruleset, however the initial classification included Open Water, Depressional Wetland, Slope Wetland, Other Vegetated, and Urban. Urban and Vegetated are merged immediately after in a “Not Interested” class, however were kept separate during training and application of the Random Forest model to prevent confusion.

The next three steps of the ruleset aim to clean up objects and prepare classes for growth. In “Remove Small Objects”, objects are merged and small objects are relegated to the not interested class to prevent future growing algorithms from wrongfully identifying wetlands. Additionally in this step, the i15 Crop Mapping, Microsoft Buildings, and C-CAP Impervious layers are used to remove incorrectly identified aquatic features. “Identify Missing Open Water” uses an NDWI threshold of 0.25 to identify Open Water features that were missed by the initial classifier. Finally, “Remove Holes in Polygons” identifies and reclassifies holes, or small islands of Not Interested objects, within larger Open Water, Depressional Wetland, and Slope Wetland objects.

Cleaning up and removing noisy small objects were essential steps leading up to the next phase of the ruleset, which pertains to growing Open Water, Depressional Wetland, and Slope Wetland objects. Open Water objects were grown using NDWI and Fill Difference, while Depressional Wetlands were grown using Fill Difference, and finally Slope Wetlands were grown using the Sentinel-2 NDVI PCA Band 3 and Slope. Once the three classes have grown, “Clean Wetland Polygons” focuses on once again removing holes from within the objects and doing minor smoothing.

“Refine Wetland Classes” is the last step before exporting the mapping as polygons. Flow Accumulation is used to identify which Open Water features are Channel, and the remainder of Open Water features are left as Open Water. For Slope Wetlands, the Canopy Height Model is used with a threshold of 30% coverage of 3m tall vegetation to determine whether a slope is Forested (FS) or a Wet Meadow (WM). All depressional wetlands are exported as Depressional Vegetated.

Once exported, the polygons were imported into ArcGIS Pro for further refinement and attribution. Lacustrine vs Depressional was determined first using a threshold of 20 acres on Open Water and Depressional Vegetated polygons. Features above the area threshold are converted to Lacustrine Open Water (LOW) and Lacustrine Vegetated (LV) respectively, or converted to Depressional Open Water (DOW) and left as Depressional Vegetated (DV). Depressional Vegetated objects bordering LOW features that did not meet the area threshold of 20 acres were classified using the Select by Location tool on a temporary layer created of LOW features. Next, the anthropogenic modifiers were applied in ArcGIS Pro. First, features that intersected dams from the i17 California Jurisdictional Dams layer were given unnatural status. Next, golf courses were selected from the three county land use layers, and intersecting depressions were assigned unnatural status. Finally, pasture and agricultural land from the i15 Crop Mapping layer were used to identify stock ponds and other agricultural water bodies as unnatural. The remaining polygons which didn't fall into the above categories were assumed natural for classification purposes.

9 SDARI Oversight and Quality Assurance and Quality Control (QAQC)

The SDARI 2024 mapping effort received feedback in the form of an ArcGIS Online (AGOL) interactive map tool. Wetland experts from the Water Quality Control Board Region 9 utilized the tool over a period of two weeks to drop points and draw polygons correcting an initial draft of the SDARI mapping. After reviewing and implementing the feedback received, each of the 34 HUC10s in the SDARI study area were reviewed one-by-one, with manual geometry and classification edits being made where needed. Feedback on the SDARI mapping will continue to be collected in the CARI editor tool from the Water Quality Control Board Region 9 staff.

10 Accuracy Assessment

An accuracy assessment of SDARI is necessary for understanding how well the mapped classes reflect the actual aquatic features on the landscape. SFEI's accuracy assessment methodology was developed by staff in collaboration with Dr. Russell G. Congalton and Dr. Kass Green, experts in the field of remote sensing classification accuracy assessment methods and authors of Assessing the Accuracy of Remotely Sensed Data (CRC Press, 2019). This accuracy assessment focuses on SDARI polygon features. A fuzzy accuracy assessment methodology was determined to be the best approach for capturing the thematic accuracy of the San Diego Aquatic Resource Inventory (SDARI), due to the inherent complexities and ambiguities of aquatic environments and the similarity between a portion of the SDARI classes. A fuzzy approach is flexible enough to allow nuances in the interpretation of aquatic systems such as temporal inundation, while remaining rigid enough to assess how well the mapped classifications match the conditions on the ground. Assessing the thematic accuracy of the mapped SDARI classifications was completed by evaluating a stratified random sample of equal sized polygon "sample units" across each of the mapped classes. Sample units were evaluated by an internal reviewer using the NAIP 2020 imagery and 1-meter DEM used in the dataset's creation. The internal reviewer was not closely involved in developing the map algorithm or manual refinement, but was familiar with the wetland class definitions. The internal reviewer was chosen in order to reduce bias as much as possible. For each of the 721 sample units, the reviewer underwent a blind review process in which they interpreted the imagery and DEM layers and reported their best determination of the aquatic feature class based on the SDARI classification definitions. After recording their primary determination of the sample unit's classification, the reviewer assigned two optional possible classification matches; the "Secondary" and "Tertiary" classifications. The "Secondary" and "Tertiary" classes provide an opportunity to select additional classes that would not be considered fully incorrect. For example the edge of a forest channel could conceivably be confused with a forested slope classification, which would not be as wrong as say, an open water lake or tidal marsh classification. By assessing how well the mapped classes matched the three possible classifications for each sample unit, we produced a fuzzy accuracy assessment with the associated user's, producer's and overall accuracy metrics.

The San Diego Aquatic Resources Inventory (SDARI) achieved an overall fuzzy accuracy of 84% (see Appendix E). While this falls just short of the 85% goal to be in compliance with CARI standards, we determined the 1% difference was small enough to incorporate the mapping into the CARI Polygons dataset. Classes with the most agreement between SDARI's mapped classes and the reviewer-assigned classifications can be found on the major diagonal of the confusion matrix in Appendix E. Open water and channel features had the highest accuracy in our accuracy assessment, indicating a reliable representation of these features on the landscape. Outside of the major diagonal are rows and columns that allow us to assess the omission and commission errors of the mapped classifications. Due to the fuzzy accuracy assessment approach, each cell outside of the diagonal has two values: the value on the left indicates the number of agreed matches in the secondary and tertiary classifications assigned to that class, while the number on the right indicates the number of other (wrong) classes assigned to that class. Based on the producer's accuracy (the inverse of omission errors) and the user's accuracy (the inverse of commission errors), tidal classes and vegetated classes had the most confusion. We expected to see confusion in these classes due to the temporal inundation of some aquatic environments and the data discrepancies associated with remotely-sensed classification methods. The temporal inundation of tidal and wetland features makes assigning specific classifications difficult, while the mis-alignment in the timing and seasonality of aerial imagery and the LiDAR flights introduces variability in the captured landscape conditions that are being classified. That said, as the SDARI remote-sensing classification piloted a Machine-Learning approach to aquatic resource mapping, we are excited by the success achieved in the dataset's accuracy assessment. Furthermore we are excited to continue to build upon this methodology and other recent aquatic resource mapping projects (Baylands Habitat Map 2020 and Russian River Aquatic Resource Inventory) to increase the accuracy and quality of these projects using more automated mapping approaches in order to address questions of change over time and efficiently extend the extent of mapping coverage.

Data availability played a crucial role in shaping the mapping process for features in the San Diego Aquatic Resources Inventory (SDARI) study area. The mapping effort encountered several significant challenges related to data quality, resolution, and timeliness. Approximately 18% of the study area was mapped using 5m resolution LiDAR data, which presents a challenge for mapping classes that rely so heavily on elevation. Furthermore, the majority of high-resolution LiDAR data available was collected between 2014 and 2016, making it 7-9 years old at the time of mapping. The most recent LiDAR data, from 2018, was only available for the Orange County section, covering about 16% of the study area. This situation meant that a large portion of the SDARI study area was mapped using relatively outdated or low-resolution information.

Acquiring high-resolution wet-season imagery proved to be another significant challenge. The best available imagery came from the National Agriculture Imagery Program (NAIP), but it was captured during the last two weeks of May in recent years. By this time in the SDARI study area, a significant amount of vegetation has already dried out, and water levels have receded, making it difficult to capture the full extent of inundation and green vegetation. To mitigate these limitations, the mapping team incorporated time series data from Sentinel-2 satellites into the process. However, Sentinel-2 imagery has a significantly lower resolution of 10 meters.

These data constraints underscore the importance of recent, high-resolution data in accurate wetland mapping and highlight the need for more frequent data collection in rapidly changing environments. Future mapping efforts could benefit from more recent LiDAR acquisitions covering a larger portion of the study area and high-resolution imagery collection during the peak wet season (e.g., March-April). By addressing these data availability issues, future iterations of the SDARI mapping could achieve even greater levels of accuracy and provide a more up-to-date representation of the region's aquatic resources.

While the overall accuracy was high, certain classes presented specific challenges:

1. Channel Vegetated: This class experienced lower accuracy, primarily due to initial ambiguities in the class definitions, particularly regarding vegetation characteristics. This ambiguity in class definitions likely also lead to differences in Producer’s vs User’s accuracies for some classes. To address this issue in future mapping efforts in the San Diego region, we plan to develop clearly defined class definitions for channel features that are fully vetted by mappers and clients at the start of any mapping projects. These definitions will include elevation cross-sections and labeled sample images, serving as valuable reference materials for mappers and reviewers alike.
2. Depressional Vegetated and Lacustrine Vegetated: These classes also showed lower accuracy rates. The challenge stemmed from the initial approach of relying heavily on LiDAR data to delineate potential open water polygons. This decision was influenced by

the extremely dry conditions in the area, which made it difficult to find imagery with significant inundation or green vegetation. Our method prioritized mapping the deepest sections of depressions as Open Water, rather than depending on imagery that inconsistently displayed greenness or wetness. This approach led to an overestimation of Open Water features and an underestimation of Vegetated features. Obtaining imagery from earlier in the year, particularly during the wet season (March-April), would provide a more representative view of the region's aquatic resources. This timing would capture peak vegetation growth and maximum water extent, allowing for more accurate delineation of vegetated and open water features.

3. Tidal Flat and Tidal Channel: The accuracy of Tidal Flat and Tidal Channel classifications in the SDARI project was hampered by data limitations, particularly the lack of recent LiDAR data and poorly timed aerial imagery. To enhance mapping accuracy for these classes, future iterations of SDARI should prioritize acquiring imagery during low-tide conditions, which would reveal the full extent of tidal flats and channels. Additionally, exploring alternative methods for estimating relative tidal elevation could significantly improve classification accuracy. Recent studies have demonstrated the potential of Sentinel-2 or other higher temporal resolution imagery for this purpose, leveraging its frequent revisit times to capture tidal variations.

11 Data Limitations

The purpose of SDARI was to map channels, wetlands and deepwater habitats in the Water Control Board region 9 to produce information on the location, type and size of these resources. The accuracy of SDARI produced through machine learning models is subject to the quality of input data, the algorithm's training process, and may not capture all nuances of wetland ecosystems. Users should exercise caution in interpreting this data, considering it as one of many tools for wetland assessment and not as a definitive source. Detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or SDARI classification.

Wetlands or other mapped features may have changed since the mapping of SDARI due to natural processes or human related activity. Therefore, there may be differences in polygon boundaries or classifications between the information depicted in the SDARI geodatabase and the current conditions on the ground. Additionally, the SDARI machine learning model's performance may be constrained by the availability and recency of data, particularly high resolution lidar. Portions of the SDARI study area did not have high-resolution lidar available, and what was available is dated from 2015-2018. It’s possible that landscape changes that occurred after these lidar flights are not reflected in the SDARI mapping.

Certain classes were excluded from the SDARI classification due to limits in time and budget. These classes are Vernal Pool Systems (VPS), Playas (PUU,PNU, etc.), Seeps and Springs (SU, SN, etc.) and Managed Wetlands (M). Future iterations of SDARI and automated wetland mapping at SFEI aim to identify and classify these features.

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Appendix A. SDARI Crosswalks to CARI

Please contact gis@sfei.org for the SDARI to NWI crosswalk.

Table A.1. SDARI to CARI Classification Crosswalk[3]

Wetland_Type	Level1	Level2	anthropogenic_modifier	Vegetation	CARI Clickcode
Channel	Non-Tidal	Channel	Natural		WRNRnnu
Channel	Non-Tidal	Channel	Unnatural		WRURnnu
Channel Forested	Non-Tidal	Channel	Natural	Woody	WRNRnnF
Channel Forested	Non-Tidal	Channel	Unnatural	Woody	WRURnnF
Channel Vegetated	Non-Tidal	Channel	Natural	Vegetated	WRNRnnv
Deep Bay	Tidal	Bay	Natural		OENESSN
Depressional Open Water	Non-Tidal	Depressional	Natural		ODNDuuN
Depressional Open Water	Non-Tidal	Depressional	Unnatural		ODUDuuN
Depressional Vegetated	Non-Tidal	Depressional	Natural	Vegetated	WDNDuuv
Depressional Vegetated	Non-Tidal	Depressional	Unnatural	Vegetated	WDUDuuv
Lacustrine Open Water	Non-Tidal	Lacustrine	Natural		OLNLnuu
Lacustrine Open Water	Non-Tidal	Lacustrine	Unnatural		OLULnuu
Lacustrine Vegetated	Non-Tidal	Lacustrine	Natural	Vegetated	WLNLnuv
Lacustrine Vegetated	Non-Tidal	Lacustrine	Unnatural	Vegetated	WLULnuv
Lagoon Open Water	Tidal	Lagoon	Unnatural		OGUGnuN
Shallow Bay	Tidal	Bay	Natural		OENESSN
Tidal Channel	Tidal	Channel	Natural		ORNRTSN
Tidal Flat	Tidal	Flat	Natural		WENESIN

[3] This table only shows SDARI classifications found in the current project extent

Tidal Marsh Panne	Tidal	Panne	Natural		WENENIN
Tidal Vegetated	Tidal	Marsh	Natural	Vegetated	WENENIv
Vernal Pool	Non-Tidal	Vernal Pool	Natural		WDNVInu
Wet Meadow Slope	Non-Tidal	Slope	Natural	Vegetated	WSNSWuH
Wet Meadow Slope	Non-Tidal	Slope	Unnatural	Vegetated	WSUSWuH
Woody Slope	Non-Tidal	Slope	Natural	Woody	WSNSFuF
Woody Slope	Non-Tidal	Slope	Unnatural	Woody	WSUSFuF

Appendix B. Field Data Corrections

Field data was collected over 10 days during early May of 2023 using a tablet set up with Survey123. Data was recorded as points, polygons and photographs. The point and polygonal data is shown in tabular format below. For the polygonal data, the coordinates of the central point of the polygon are included as the latitude and longitude. 418 points, 47 polygons, and 1,185 photos were recorded during the field visits. Please contact SFEI's GIS team for more information at gis@sfei.org.

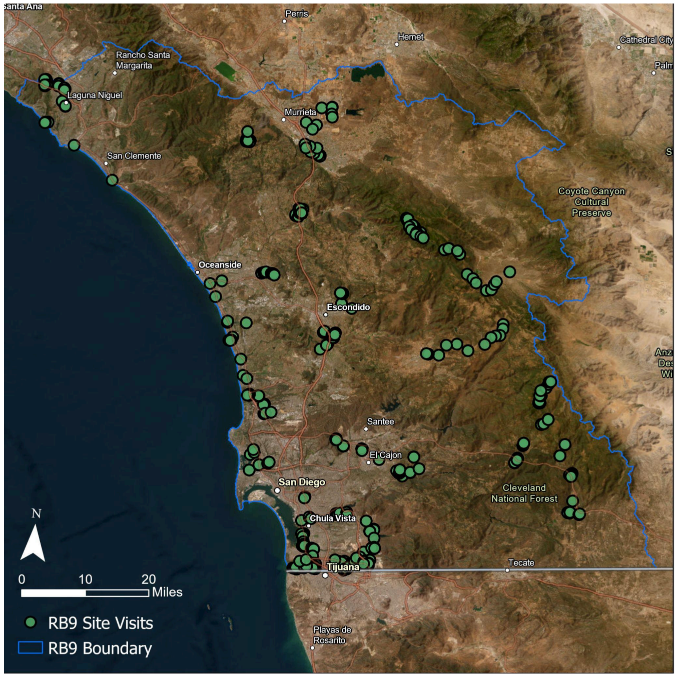

***Figure 14**: Map of RB9 field visit sites.*

***Table 6.** Tabular representation of point data taken during the SDARI field visits.*

Site ID	Class	Notes	Date	Latitude	Longitude
1,2	upland	bare sandy soil, same on ds side of road	5/1/2023	32.843613	-116.527194
1,2		riverine channel and vegetated floodplain	5/1/2023	32.843582	-116.526757
1,2	riverine floodplain	floodplain with scale, not wet often, bare sandy soil with sage and willow	5/1/2023	32.843739	-116.526388

1,4	riverine and floodplain	yes	5/1/2023	32.869323	-116.516787
1,4	floodplain	no poly? should be	5/1/2023	32.869743	-116.516914
1,5	seasonal depression	Junius etc, 4 sp photos	5/1/2023	32.860569	-116.612296
1,5	ephemeral channel	flowing about 1m wide	5/1/2023	32.864095	-116.610838
1,5	seep	coming from road and roadcut	5/1/2023	32.865721	-116.610843
1,7	riverine		5/1/2023	32.911072	-116.574014
1,7	riverine	yes	5/1/2023	32.913479	-116.569177
1,8	forested riverine	yes, likely needs to be wider, like 25m	5/1/2023	32.924126	-116.55953
1,8	riverine	is 9m wide	5/1/2023	32.923985	-116.559725
1,9	riverine	has flow	5/1/2023	32.959901	-116.580707
	riverine	yes	5/1/2023	32.95983	-116.583864
	riverine	just offset	5/1/2023	32.962964	-116.583212
1,9	riverine	not well defined channel, vegetated	5/1/2023	32.964277	-116.582865
1,9	wet meadow	carex juncus yarrow squishy soil	5/1/2023	32.964384	-116.582541
1,9	riverine	not mapped	5/1/2023	32.96345	-116.582537
1,10	riverine	fix this mapping	5/1/2023	32.976013	-116.579617
1,10	wet meadow	carex juncus	5/1/2023	32.975989	-116.580115
1, 10	riverine	ditch parallels road	5/1/2023	32.976391	-116.580914

1,11	wet meadow	emergent	5/1/2023	32.976771	-116.580428
1,11	forested wet meadow	black and arroyo willows	5/1/2023	32.9773	-116.580038
1,11	riverine	continues under road	5/1/2023	32.976665	-116.579656
1,11	wet meadow shrub		5/1/2023	32.976891	-116.579444
1,11	wet meadow emergent	yes	5/1/2023	32.976751	-116.582634
1,12	upland	just upland to other side of fence, then standing water of lake	5/1/2023	32.995074	-116.569563
1,13	wet meadow	emergent, series of bowls within larger meadow	5/1/2023	33.003678	-116.564951
1,13	wet meadow	emergent, larger than mapped	5/1/2023	33.009331	-116.563653
1,13	wet meadow	yes	5/1/2023	33.010193	-116.560439
1,13	lacustrine	yes	5/1/2023	32.98834	-116.581341
x,x	riverine	this is the connection point between the river and upstream marsh	5/3/2023	32.757143	-117.229143
2,1	culvert	This is where the depression drains	5/2/2023	33.607831	-117.758206
2,1	riverine	channel actually goes here	5/2/2023	33.607685	-117.758249

2,2	lacustrine	please map, drains to rb9, Barbara lake	5/2/2023	33.609269	-117.757586
2,2	depression	didn't actually see, but looks like it. photo	5/2/2023	33.606353	-117.756483
2,3	depressional unnatural	detention basin bmp	5/2/2023	33.607014	-117.760859
2,3	riverine	please map as it drains into Rb9	5/2/2023	33.608176	-117.761386
2,4	riverine	straighline ditch along fenceline	5/2/2023	33.594762	-117.75999
2,4	upland	this is just sycamore trees on hills lope. 2 photos	5/2/2023	33.594218	-117.759627
2,4	drop structures	takes ditch under road to creek	5/2/2023	33.593875	-117.759709
2,4	nothing	no culvert under road	5/2/2023	33.595297	-117.760235
2,5	upland	it's a sycamore grove. did not walk in. photo	5/2/2023	33.594762	-117.758897
2,5	riverine	photos with bridge	5/2/2023	33.595365	-117.757744
2,5	upland	sycamore grove on upland, photos	5/2/2023	33.596862	-117.75575
2,5	riverine	doesn't cross path, but flows down on east side of trail, and distributary	5/2/2023	33.596738	-117.755714

2,5	upland	all blue blob is wrong, all upland, photos	5/2/2023	33.596529	-117.760243
2,6	upland	it's the putting green and houses	5/2/2023	33.60031	-117.728275
2,6	depressional	check size	5/2/2023	33.601551	-117.728302
2,6	riverine	it's a swale, but has culverts. mapped offset	5/2/2023	33.6006	-117.728128
2,7	upland	not wetland	5/2/2023	33.595731	-117.72837
2,8	depressional	unmapped	5/2/2023	33.590169	-117.713459
2,8	depressional	unmapped	5/2/2023	33.589559	-117.713221
2,8	riverine	looks great	5/2/2023	33.5922	-117.714781
2,8	upland	historic floodplain but now upland. possibly planted. strange mix of species.	5/2/2023	33.592545	-117.715248
2,8	riverine	why the depressional poly. no need. channel is 3m wide	5/2/2023	33.587813	-117.714388
2,8	depressional	couldn't get there but really likely depression	5/2/2023	33.562219	-117.716959
2,8	riverine	yup	5/2/2023	33.561998	-117.717289
2,8	forested floodplain	wide and dense riparian, photos	5/2/2023	33.562517	-117.717362

2,10	depressional	blocked stream	5/2/2023	33.551083	-117.709534
2,10	riverine	yes. with typha and scirpus americanus. photos. super weird.	5/2/2023	33.552247	-117.70961
2,11	tidal riverine	add tidal riverine from here downstream	5/2/2023	33.512158	-117.745826
2,11	upland	not depressional, just veg on banks. photos.	5/2/2023	33.511916	-117.751734
2,11	tidal riverine	currently open mouth. how do we map this.?	5/2/2023	33.51062	-117.752903
2,12	estuarine channel	shouldn't change classes under bridge	5/2/2023	33.391497	-117.59034
2,13	riverine		5/2/2023	33.464361	-117.682749
	fake 2	fake 2	4/27/2023	33.35852	-117.152605
2,x	bbe	check with rb9, Debbie said there is a weir that keeps this all freshwater, not saline. didn't stop here.	5/3/2023	33.088925	-117.304119
2,x	depressional	map all ponds here. did not visit	5/3/2023	33.090967	-117.261292
	fake		4/27/2023	32.803652	-116.936312

1,14	not a wetland	looks new build. has LID	5/2/2023	32.822208	-116.975802
1,14	not a wetland	new build	5/2/2023	32.82376	-116.975846
1,14	LID basin for new build		5/2/2023	32.825328	-116.977451
1,14	riverine	yes. it scores a 28 in cram	5/2/2023	32.820948	-116.976269
3,5	depressional open water	map open water poly	5/3/2023	32.909723	-117.206158
3,5	forested slope	Cottonwood willow ash sycamore	5/3/2023	32.909122	-117.207566
3,5	slope emergent	anamopsis, cram training site	5/3/2023	32.9076	-117.208332
3,6	Vernal pool system	three pools	5/3/2023	32.926648	-117.220857
3,5	vp		5/3/2023	32.926854	-117.220708
3,5	vp		5/3/2023	32.926876	-117.220425
3,5	vp		5/3/2023	32.926954	-117.220505
3,5	vp	and swale headed to southwest	5/3/2023	32.926643	-117.220332
3,5	vp		5/3/2023	32.926717	-117.22009
3,5	vp		5/3/2023	32.926537	-117.219933
3,5	vp	fenced so couldn't see	5/3/2023	32.926293	-117.220448
3,6	vp	sp may have mislabeled these as 3,5	5/3/2023	32.927518	-117.220442
3, 7	riverine	did not visit, but Debbie has and says it's ok	5/3/2023	32.887724	-117.205206

3,x	upland	just trees, did not visit	5/3/2023	32.888827	-117.202576
3,x	upland	did not visit, driving range. many others nearby	5/3/2023	32.892008	-117.189627
3,8	riverine	creek is actually here	5/3/2023	32.929659	-117.241553
3,8	Woody slope	freshwater willows, it's like a delta. with riverine through it	5/3/2023	32.928797	-117.242335
3,8	fresh non woody slope	grasses willow juncus tule in swales	5/3/2023	32.92669	-117.242589
3,8	tidal marsh		5/3/2023	32.926679	-117.246049
3,9	riverine	move blueline into the riparian	5/3/2023	32.828551	-117.019711
3,9	riparian	it's red willow riparian, not depression	5/3/2023	32.827912	-117.019507
3,9	riverine	yes	5/3/2023	32.828613	-117.020001
3,10	riverine	add blueline draining pond here	5/3/2023	32.841115	-117.037608
3,10	upland	mustard berm	5/4/2023	32.843072	-117.036747
3,10	riverine	move blueline over here	5/4/2023	32.842559	-117.038243
3,10	riverine	bend trib blueline here, joins mainstem branch	5/4/2023	32.841212	-117.03644
3,1	estuarine	Marsh with channels	5/3/2023	32.792593	-117.229592

3,3	tidal channel	can see tidal range, riparian, pickleweed	5/3/2023	32.798204	-117.220912
3,3	riverine	this is where it transitions from fresh to tidal	5/3/2023	32.804319	-117.222997
3,4	tidal marsh	map the marsh edges	5/3/2023	32.770179	-117.208083
3,4	tidal marsh	map the edges	5/3/2023	32.770919	-117.208079
3,x	upland	did not go there. VERY suspect, likely just trees	5/3/2023	32.775186	-117.188196
3,x	riparian?	did not go there, likely just riparian	5/3/2023	32.778339	-117.185154
4,x	riverine	add blueline	5/4/2023	33.556696	-117.160086
4,x	depressional	saw it!	5/4/2023	33.359438	-117.161813
4,x	riverine	saw it	5/4/2023	33.342729	-117.167583
4,x	upland	upland field	5/4/2023	33.346037	-117.16781
4,x	riverine	move bluline here	5/4/2023	33.341252	-117.161537
4,x	riverine	move blueline	5/4/2023	33.350087	-117.159695
4,x	riverine	stream crosses here	5/4/2023	33.359025	-117.157937
4,6	upland	native shrubs on flat surfave	5/4/2023	33.348526	-117.154242
4,6	upland	here is where it steps up to upland	5/4/2023	33.34849	-117.155869
4,6	riverine	lowest spot, no defined channel	5/4/2023	33.348524	-117.155339

4,6	forested slope	planted and irrigated hodgepodge	5/4/2023	33.34844	-117.154958
4,6	riverine	swale crosses here	5/4/2023	33.348465	-117.155499
4,6	riverine	continuation of swale	5/4/2023	33.348335	-117.155543
4,6	forested slope	fix the width and position	5/4/2023	33.350055	-117.1553
4,1	riverine	yes, just scoot it over	5/4/2023	33.483386	-117.122991
4,1	upland	not wetland, just veg	5/4/2023	33.482996	-117.123099
4,1	upland	swimming pool with an amazing water slide	5/4/2023	33.482401	-117.122904
4,1	upland	horse pasture	5/4/2023	33.481822	-117.123432
4,2	depressional	did not see it, but from 1 block away could see the ds side berm. likely real	5/4/2023	33.484685	-117.126848
4,2	depressional	this is a construction bmp, holding water and flowing discharge because it's raining	5/4/2023	33.487864	-117.136714
4,2	riverine	concrete ditch	5/4/2023	33.490394	-117.145013
4,2	depressional	yes, this and two adjacent features	5/4/2023	33.502396	-117.150385

4,2	depressional	just clean this up	5/4/2023	33.499982	-117.130895
4,x	depressional	duck pond with fountain . photos from car	5/4/2023	33.502628	-117.147403
4,3	riverine	add a blueline. it's a ditch type thing higher than river	5/4/2023	33.506456	-117.159416
4,x	riverine	add blue line, ditch	5/4/2023	33.498462	-117.156239
4,4	Vernal pool system	check size to see if individual.	5/4/2023	33.505751	-117.292043
4,4	Vernal pool		5/4/2023	33.507579	-117.292481
4,4	individual Vernal pool		5/4/2023	33.505683	-117.283811
4,4	Vernal pool		5/4/2023	33.502671	-117.284859
4,4	Vernal pool		5/4/2023	33.508109	-117.290817
4,4	Vernal pool system	resto in progress	5/4/2023	33.503228	-117.292879
4,4	riverine	considering vp swale	5/4/2023	33.505147	-117.289247
4,4	riverine	Def riverine on this side of road	5/4/2023	33.504296	-117.289272
4,4	Vernal pool system		5/4/2023	33.525264	-117.291536
4,5	riverine		5/4/2023	33.591611	-117.127651

5,2	upland	just succulent on hillslope. couldn't get there, but could confirm with veg color on hillslope in culdesac	5/5/2023	33.044142	-117.089225
5,3	depressional forested	photos for you	5/5/2023	33.056549	-117.073431
5,3	riverine	just a blueline that ends in the depression. Shrubs are on banks	5/5/2023	33.054021	-117.075178
5,4	riverine	blueline with riparian on the banks. no poly here.?	5/5/2023	33.082663	-117.084867
5,5	depressional	detention basin	5/5/2023	33.08348	-117.08325
5,5	forested slope	wide spot with floodplain	5/5/2023	33.084632	-117.084051
5,5	riverine	fix this	5/5/2023	33.085211	-117.082457
5,6	riverine	riparian is on banks. cattail in channel	5/5/2023	33.072064	-117.060315
5,6	depressional	open water with a ring of cattail	5/5/2023	33.072642	-117.062899
5,5	upland	delete this string	5/5/2023	33.078044	-117.064363
5,7	forested depression	swampy mess of willow palm grape scirpus	5/5/2023	33.081932	-117.059236

5,7	forested slope	remove tennis courts and either shrink emergent or just lump it in with forested	5/5/2023	33.083386	-117.0574
5,7	depressional	yes	5/5/2023	33.078725	-117.06206
5,7	riverine	just scoot over	5/5/2023	33.079488	-117.060563
5,8	forested depressional	yes	5/5/2023	33.079262	-117.057995
5,9	unknown	can't comment only saw from above. lots of palms. possible forested slope	5/5/2023	33.141943	-117.024416
5,x	upland	did not see	5/5/2023	33.151186	-117.04851
5,10	depreesional open water	yes, open water with outer ring of emergent cattails and tule. some willows along the edge	5/5/2023	33.17384	-117.0496
5,10	riverine	actual drain point. natual out, continues ds	5/5/2023	33.174134	-117.048334
5,10	upland	not the drain point. there is a steep ravine along the face of the dam	5/5/2023	33.173416	-117.049481
5,10	riverine	feeding ds pond	5/5/2023	33.174407	-117.047634

5,10	depressional	unnatural. open water with cattail and willow on outside edge	5/5/2023	33.17368	-117.047213
5,10	riverine	thus is actually OUT	5/5/2023	33.174359	-117.047579
5,10	riverine	drains upper lake to lower lake. dry now	5/5/2023	33.174537	-117.048053
5,10	riverine	yes creek really does curve, but scoot here	5/5/2023	33.173773	-117.051583
5,10	forested slope	wide spot in river, floodplain with willow and herby veg. perhaps slightly smaller poly tho	5/5/2023	33.175317	-117.053005
6,14	depressional	probably only an open water and a forested outer ring	5/8/2023	32.565036	-116.997563
6,14	upland	slope up to highway	5/8/2023	32.564588	-116.997274
6,14	upland	patch of arundo phragmites type of veg	5/8/2023	32.564687	-116.997093
6,14	riverine	yes	5/8/2023	32.563356	-116.997761
6,14	depressional	yes	5/8/2023	32.566952	-116.997536
6,14	depressional	yes but scoot south	5/8/2023	32.561656	-116.996613
6,14	riverine	scoot to bottom of canyon	5/8/2023	32.560145	-116.996924

6,14	riverine	drains the depression	5/8/2023	32.561053	-116.996643
6,14	Vernal pool system	project. but tons of natural on the mesa.	5/8/2023	32.565363	-117.008879
6,14	Vernal pool system	add these	5/8/2023	32.564004	-117.003
6,15	Vernal pool system	map the rest of these in here?	5/9/2023	32.546126	-116.997677
6,15	upland	recent graded	5/9/2023	32.547907	-116.997637
6,15	Vernal pool	looks like they are grading new pools. this will be new one	5/9/2023	32.547723	-116.997323
6,15	depressional	yes. not sure upstream blue line is real.	5/9/2023	32.549267	-116.991293
6,15	riverine	just scoot over	5/9/2023	32.550014	-116.993676
6,15	upland	no wetland	5/9/2023	32.55518	-116.986208
6,1	tidal channel	channel, but still clearly tidal. Saline because we see pacific oyster on pillars	5/8/2023	32.651502	-117.101713
6,2	riverine	yes	5/8/2023	32.660802	-117.084612
6,2	estuarine	this is the HOT	5/8/2023	32.657778	-117.080388
6,3	riverine	scoot over to here	5/8/2023	32.622425	-117.094039
6,3	estuarine	tidal marsh	5/8/2023	32.61974	-117.098512

6,3	upland	perhaps filled. not even remnant anything. not riverine.	5/8/2023	32.621839	-117.09832
6,3	upland	histically it was probably something, but no wetland indicators currently	5/8/2023	32.621108	-117.099441
6,3	depressional	didn't actually set foot. please look carefully. just has the feel of depression pockets	5/8/2023	32.615736	-117.095822
6,3	salt pond		5/8/2023	32.603786	-117.093571
6,3	salt pond		5/8/2023	32.598283	-117.091878
6,4	estuarine channel	yes	5/8/2023	32.594775	-117.091181
6,4	riverine	tule cattail, freshwater	5/8/2023	32.593196	-117.092644
6,4	riverine	it's actually fresh, not estuarine	5/8/2023	32.594768	-117.091208
6,4	upland	usfws restoration. maybe plants, but no other screaming evidence of wetland. ask if a jd exists	5/8/2023	32.593695	-117.09194

6,4	culverts	new culverts set here likely keeping upstream riverine	5/8/2023	32.594687	-117.092674
6,4	tidal estuarine	see pickleweed in channel here, likely VERY muted because of distance from bay	5/8/2023	32.594791	-117.092111
6,4	salt pond	active?	5/8/2023	32.595407	-117.09258
6,4	estuarine	clearly tidal, pickleweed etc	5/8/2023	32.594793	-117.094907
6,4	tidal marsh	do a better job of mapping unveg channel and poly of marsh on either side	5/8/2023	32.594566	-117.095492
6,4	estuarine channel	grade control structure. hear water drop	5/8/2023	32.594791	-117.094019
6,4	riverine	concrete channels	5/8/2023	32.594808	-117.09038
6,5	depressional	tiny pocket of tule	5/8/2023	32.588218	-117.07259
6,5	depressional	open water	5/8/2023	32.588756	-117.073387
6,5	depressional vegetated	ring of tule with willow baccharis pepper tree on outside edge	5/8/2023	32.588448	-117.073685
6,5	forested slope	forested floodplain	5/8/2023	32.590224	-117.073829

6,5	riverine	did not see, but looks like it goes here.	5/8/2023	32.591055	-117.07399
6,5	upland	restoration site	5/8/2023	32.587866	-117.072975
6,5	depressional emergent	can see the tules	5/8/2023	32.589082	-117.071572
6,5	riverine	culvert under trail	5/8/2023	32.588387	-117.070849
6,5	depressional	open water	5/8/2023	32.589192	-117.069566
6,5	depressional	tule, depressional emergent	5/8/2023	32.588889	-117.069723
6,5	depressional	photos from here, depressional emergent	5/8/2023	32.588494	-117.069303
6,5	riverine	culvert under trail	5/8/2023	32.58854	-117.06917
6,6	riverine	dry detention basin, not wetland, but defined drain starts here	5/8/2023	32.573249	-117.070379
6,7	depressional	open water	5/8/2023	32.555138	-117.064376
6,7	depressional emergent	tule on the fringes	5/8/2023	32.556188	-117.063896
6,7	depression forested	willows black and arroyo, some around mixed in	5/8/2023	32.556634	-117.063176
6,7	depressional	not sure if any open water but tons of tule	5/8/2023	32.553495	-117.063696
6,7	depressional forested	yes	5/8/2023	32.556894	-117.068239

6,7	depressional forested	mapping should cover this entire poly	5/8/2023	32.557098	-117.069856
6,7	depressional forested	this should be mapped also	5/8/2023	32.557127	-117.07338
6,7	depressional	open water	5/8/2023	32.554763	-117.061654
6,8	riverine	channel goes through this triangle	5/8/2023	32.549947	-117.06442
6,8	riverine forested	willows with wet feet	5/8/2023	32.550238	-117.064741
6,8	riverine	scoot over	5/8/2023	32.551539	-117.067057
6,8	riverine forested	willows but with emergent too	5/8/2023	32.548346	-117.063483
6,8	forested slope	do we map riverine or slope. it's a wet soupy mess, not a dry floodplain.	5/8/2023	32.550277	-117.067971
6,9	riverine	add this branch	5/8/2023	32.544666	-117.061939
6,9	upland	parking lot	5/8/2023	32.545213	-117.067252
6,9	riverine	add this arm	5/8/2023	32.546317	-117.065181
6,9	slope emergent	floodplain in between arms	5/8/2023	32.546703	-117.063922
6,9	riverine	tiny drain	5/8/2023	32.544954	-117.067759
6,10	riverine	yes	5/8/2023	32.544012	-117.088334
6,10	upland	bermed so it's dry	5/8/2023	32.5468	-117.0907
6,10	riverine	sed basin, move river to here	5/8/2023	32.540366	-117.104641

	upland	euc grove, not a wetland	5/8/2023	32.543506	-117.103502
6,11	depressional	no estuarine east of monument road	5/8/2023	32.542086	-117.11329
6,11	depressional	sed basin	5/8/2023	32.54069	-117.105206
6,11	river	add channel draining basins	5/8/2023	32.542174	-117.108982
6,11	forested slope	not saline, unsure if road is bermed	5/8/2023	32.542376	-117.113173
6,11	forested slope	all this should be mapped	5/8/2023	32.541899	-117.110415
6,11	forested slope	sea of mulefat, not riverine	5/8/2023	32.544028	-117.106467
6,12	forested depressional	willow forest and bermed	5/8/2023	32.550496	-117.08482
6,12	depressional forested	willows and bermed	5/8/2023	32.549004	-117.086527
6,12	riverine	yes	5/8/2023	32.551466	-117.084132
6,12	depressional forested	willows and bermed	5/8/2023	32.547172	-117.086941
6,12	forested depression	willow mulefat	5/8/2023	32.5489	-117.082014
6,13	upland	buildings	5/8/2023	32.55923	-117.098796
6,13	riverine	concrete channel	5/8/2023	32.563656	-117.083788
7,1	riverine	resto site. don't know what they aimed to do	5/9/2023	32.705934	-117.098009

7,1	upland	river banks. quite incised so there would be plantings and upland species.	5/9/2023	32.703531	-117.09924
7,1	forested slope	it's the floodplain, but mustard castor bean etc, probably not wetland, just riparian	5/9/2023	32.703667	-117.099094
7,1	riverine	move blue line here	5/9/2023	32.703744	-117.099156
7,1	riverine	oops, other dot is mistake. this is the blue line	5/9/2023	32.703753	-117.099001
7,2	depressional	open water	5/9/2023	32.672782	-117.023513
7,2	depressional emergent	cattail and tule, not quite a consistent ring	5/9/2023	32.672653	-117.024258
7,2	depressional forested	black and arroyo willow	5/9/2023	32.672911	-117.024195
7,2	riverine	incoming	5/9/2023	32.673124	-117.024632
7,2	riverine	yes, diffuse outlet, can see flow	5/9/2023	32.671079	-117.023929
7,2	forested depression	outlet, willows in water, tule, bars	5/9/2023	32.671234	-117.023776

7,2	riverine	inlet to depression. wide valley bottom has willow mulefat and small channels	5/9/2023	32.673276	-117.022221
7,2	forested slope	inlet area to depression	5/9/2023	32.673216	-117.022704
7,2	riverine	blue line actually goes here	5/9/2023	32.673459	-117.021262
7,2	riverine	yes	5/9/2023	32.674973	-117.016421
7,2	riverine	yes	5/9/2023	32.677979	-117.00055
7,2	riverine	yes	5/9/2023	32.673014	-116.999277
7,3	upland	right position but no wetland veg	5/9/2023	32.644807	-116.935982
7,3	riverine	tiny drainage, you can overrule me, but if large enough you can add a blueline	5/9/2023	32.643533	-116.935953
7,3	riverine	good enough	5/9/2023	32.643075	-116.935642
7,4	depressional	yes	5/9/2023	32.638875	-116.945145
7,4	depressional	yes, drainage choked with cattail backed behind ds berm	5/9/2023	32.639199	-116.944698
7,4	depressional forested	willows along edges	5/9/2023	32.638758	-116.944321

7,4	depressional emergent	should probably map this entire series similar to ds, with each pocket blocked by a berm or road	5/9/2023	32.662109	-116.954771
7,5	depressional emergent	yes	5/9/2023	32.624361	-116.934119
7,5	Vernal pool system	area mapped well, just reclassify	5/9/2023	32.603656	-116.93238
7,6	riverine	scoot over to here	5/9/2023	32.600294	-116.9334
7,6	Vernal pool	look at Lindsay's map for vps in this area	5/9/2023	32.601145	-116.932632
7,6	riverine	move blueline to here	5/9/2023	32.599047	-116.934406
7,6	depressional	new depression	5/9/2023	32.601909	-116.937599
7,6	river5	move blueline to here	5/9/2023	32.601504	-116.937596
7,6	forested slope	with bleline	5/9/2023	32.600965	-116.931059
7,x	upland		5/9/2023	32.564195	-116.953296
7,x	riverine		5/9/2023	32.568392	-116.974456
7,7	Vernal pool system	mounds with shrubs and pools in between	5/9/2023	32.578927	-116.96275
7,7	Vernal pool system	map these too	5/9/2023	32.576199	-116.970088

7,x	upland	no	5/9/2023	32.571687	-116.950324
7,8	depressional	artificial depressional	5/9/2023	32.572844	-116.941937
7,8	upland	thought it was vp, but nothing obvious	5/9/2023	32.572685	-116.940909
7,8	upland	let's ask Lindsay if she knows	5/9/2023	32.573418	-116.939569
7,9	upland	this is nothing	5/9/2023	32.569829	-116.952874
7,10	uoland	now construction. nothing left	5/9/2023	32.560986	-116.942501
7,10	upland		5/9/2023	32.564026	-116.942409
7,10	riverine		5/9/2023	32.564687	-116.94222
7,10	depressional	excavation pit, still there, but map better	5/9/2023	32.566712	-116.942146
7,10	upland		5/9/2023	32.565501	-116.94257
7,10	upland		5/9/2023	32.564273	-116.9533
7,10	upland	get rid of this cluster	5/9/2023	32.567956	-117.018662
8,5	riverine	follows slope on west side of slope	5/10/2023	32.823705	-116.625852
8,5	riverine	super incised	5/10/2023	32.82354	-116.625164
8,5	upland	grassland swale with marginal wetland plants	5/10/2023	32.823252	-116.625053

8,5	slope emergent	slope continues up here, just this side channel. rose juncus carex	5/10/2023	32.823541	-116.62547
8,5	slope emergent	total wet meadow with horse ranch	5/10/2023	32.819378	-116.628532
8,5	riverine	add the creek to the meadow	5/10/2023	32.820551	-116.627661
8,6	riverine		5/10/2023	32.827704	-116.623062
8,6	riverine	tiny drainagee	5/10/2023	32.827652	-116.62227
8,6	riverine	riverine. willows growing on banks	5/10/2023	32.828363	-116.622025
8,6	riverine		5/10/2023	32.82957	-116.622397
8,6	riverine		5/10/2023	32.830115	-116.621815
8,6	slope emergent	continue along riparian	5/10/2023	32.829963	-116.622333
8,6	depressional open water		5/10/2023	32.830966	-116.622709
8,6	slope emergent	delta of two creeks	5/10/2023	32.830543	-116.62248
8,6	slope forested	willows with juncus carex underneath	5/10/2023	32.83061	-116.622766
8,6	riverine		5/10/2023	32.828894	-116.623965
8,6	slope emergent		5/10/2023	32.826722	-116.623123
8,7	depressional open water	like a small reservoir	5/10/2023	32.80205	-116.497871
8,7	slope emergent	the delta area. should it still be depressional?	5/10/2023	32.804184	-116.496073

8,7	riverine	yes	5/10/2023	32.805762	-116.495986
8,7	depressional forested	not sure this deserves. willows	5/10/2023	32.801863	-116.497449
8,7	riverine	yes	5/10/2023	32.801333	-116.501711
8,7	riverine	do better	5/10/2023	32.798496	-116.497984
8, 8	slope emergent	mapped well, but wrong class	5/10/2023	32.743306	-116.489857
8,8	slope emergent		5/10/2023	32.71493	-116.494839
8,9	forested slope	riverine floodplain with willows	5/10/2023	32.715983	-116.499267
8,9	upland	just doesn't feel wet. sandy, no soil profile, sage, and upland grasses	5/10/2023	32.715589	-116.498748
8,9	unknown	couldn't get out here	5/10/2023	32.716833	-116.493751
8,10	slope emergent	can see dark veg	5/10/2023	32.713056	-116.473086
8,10	slope emergent	continue emergent around drainage the entire way downstream the meadow	5/10/2023	32.715069	-116.47133
8,2	riverine	yes, channel with veg on banks	5/10/2023	32.774348	-116.884788

8,1	upland	in a topographic bowl, but likely just dark veg on the very steep hillslope	5/10/2023	32.781104	-116.893981
8,2	riverine	continue mapping the poly ds of bridge	5/10/2023	32.769989	-116.880636
8,2	upland		5/10/2023	32.775763	-116.888706
8,2	depressional	yes	5/10/2023	32.777096	-116.886934
8,2	riverine	yes	5/10/2023	32.780153	-116.887112
8,2	upland	fix this	5/10/2023	32.783871	-116.887102
8,3	lacustrine	yes	5/10/2023	32.779084	-116.863173
8,3	depresforested	ring of mixed willow	5/10/2023	32.77967	-116.863672
8,3	upland		5/10/2023	32.789774	-116.843964
8,4	riverine	road ditch drains here	5/10/2023	32.815649	-116.857925
8,4	upland	oaks. possibly collecting in a swaleish, but not enough evidence to call it wet	5/10/2023	32.81527	-116.85778
9,1	riverine	scoot over	5/11/2023	33.59559	-117.104
9,1	river	yes. willows growing on waters edge. non wetland floodplain.	5/11/2023	33.594595	-117.104413
9,x	upland		5/11/2023	33.58015	-117.103718

9,x	riverine	yes	5/11/2023	33.572733	-117.101982
9,x	riverine	yes	5/11/2023	33.552088	-117.136248
9,x	riverine	yes	5/11/2023	33.542263	-117.144443
9,5	upland	this part def dry. brome dominated	5/11/2023	33.291268	-116.82398
9,5	slope emergent	I could buy the lower part as wet	5/11/2023	33.294736	-116.814838
9,5	slope emergent	yes, just the lower part is wet	5/11/2023	33.283626	-116.788712
9,5	depressional	yes	5/11/2023	33.290788	-116.794414
9,6	riverine	yes	5/12/2023	33.239599	-116.768865
9,6	depressional foested	willows currently under water	5/12/2023	33.230335	-116.7546
9,6	slope emergent	clean up current mapping	5/12/2023	33.22151	-116.746566
9,6	depressional	standing water	5/12/2023	33.206138	-116.722167
9,6	depressional	tiny behind road berm	5/12/2023	33.208587	-116.710705
9,6	riverine	yes	5/12/2023	33.220717	-116.705309
9,6	riverine	yes	5/12/2023	33.22763	-116.70114
9,7	depressional emergent	tule and bolboschoenus	5/12/2023	33.252145	-116.672465
9,x	depressional	saw it, ag pond	5/12/2023	33.132145	-116.677966
9,x	riverine	yes	5/12/2023	33.121714	-116.677746
9,x	riv	yes	5/12/2023	33.106548	-116.683388

9,x	depressional	stock pond	5/12/2023	33.104213	-116.693212
9,x	depressional	saw it. fix mapping	5/12/2023	33.099826	-116.703552
9,x	depressional	fix mapping, saw it	5/12/2023	33.083093	-116.716154
9,x	slope emergent		5/12/2023	33.065814	-116.753234
9,x	slope emergent	juncus	5/12/2023	33.079202	-116.779525
9,x	dep	tiny duck pond	5/12/2023	33.074711	-116.80318
9,x	upland	these are oaks	5/12/2023	33.050854	-116.819063
9,x	riverine	yes	5/12/2023	33.051266	-116.842698
9,x	depressional	saw it	5/12/2023	33.052008	-116.847404
9,2	depressional	open water	5/11/2023	33.340132	-116.901296
9,2	riverine	yes	5/11/2023	33.340858	-116.902061
9,2	depressional emergent	cattails	5/11/2023	33.340139	-116.900972
9,2	river	this is the outlet	5/11/2023	33.34054	-116.901571
9,2	slope emergent	wet meadow juncus nettle deer grass checker mallow, mugwort, yarrow	5/11/2023	33.338801	-116.898472
9,2	slope em	all meadow one thing	5/11/2023	33.339855	-116.89933
9,2	riverine		5/11/2023	33.336995	-116.896046
9,2	riverine	yes	5/11/2023	33.339338	-116.900813
9,3	slope emergent	juncus deer Grass	5/11/2023	33.35631	-116.916009

9,3	slope	check density to see if forested or emergent	5/11/2023	33.350019	-116.911027
9,3	slope emergent		5/11/2023	33.34655	-116.907991
9,3	riverine	yes	5/11/2023	33.351178	-116.913323
9,3	riverine	yes	5/11/2023	33.354436	-116.913354
9,3	riverine	yes	5/11/2023	33.354437	-116.912206
9,2	riverine		5/11/2023	33.341363	-116.901082
9,4	slope em	Bracken fern hillslope. map all the orange spots	5/11/2023	33.337691	-116.908007
9,4	slope emergent	fern	5/11/2023	33.330624	-116.903022
9,4	depressional	map it better	5/11/2023	33.326439	-116.881675
9,x	slope emergent	did not see, but looks slope	5/11/2023	33.325684	-116.890482
9 x	slope emergent	juncus	5/11/2023	33.321436	-116.891872
9,x	slope emergent	fern deer grass	5/11/2023	33.317158	-116.879904
9,x	depressional	didn't see	5/11/2023	33.314357	-116.874433
10,1	riverine	yes. super incised riparian along banks. certification site	5/12/2023	33.20613	-117.235454
10,1	riverine	less incised due to historic grade controls, but still just riparian	5/12/2023	33.208396	-117.230521
10,2	riverine	yes	5/12/2023	33.209198	-117.226741

10,2	riverine	yes	5/12/2023	33.209186	-117.224306
10,2	depressional	Kimberly is checking the grading to see if truly holding water. old project	5/12/2023	33.20967	-117.225367
10,3	depressional	yes	5/12/2023	33.20725	-117.213147
10,3	depressional	yes	5/12/2023	33.207774	-117.21016
10,3	depressional	yes. all these in line ponds are good	5/12/2023	33.206279	-117.207752
10,3	depressional	yes	5/12/2023	33.204394	-117.206279
10,x	riverine	willow thicket along channel	5/12/2023	33.181751	-117.324099
10,x	lagoon	cattail. it is fresh, managed to always be fresh	5/12/2023	33.174052	-117.350256
10,x	lagoon	open water, like no veg on the sides	5/12/2023	33.145388	-117.335599
10,x	tidal estuarine	salt marsh	5/12/2023	33.091766	-117.304087
10,x	riverine	yes	5/12/2023	33.056032	-117.290067
10,x	riverine	yes	5/12/2023	33.049163	-117.292212
10,4	riverine	all freshwater veg. no evidence of tidal	5/12/2023	33.048342	-117.297319
10,4	riverine	it does a jiggy jag	5/12/2023	33.048456	-117.297574
10,4	riverine	small little trib	5/12/2023	33.047953	-117.294606

10,4	upland	lovely restoration but not hydro connected to channels. don't think wetland	5/12/2023	33.048174	-117.294798
10,x	tidal emergent	salt marsh	5/12/2023	33.007348	-117.267588
10,x	tidal estuarine	marsh restoration. channels and emerg	5/12/2023	32.971037	-117.259382
10,x	tidal estuarine	salt marsh	5/12/2023	32.964537	-117.250244

Table 7. *Tabular representation of polygon data taken during the SDARI field visits. The coordinates represent the central point of each polygon.*

Site ID	Class	Notes	Date	Latitude	Longitude
	Sarah	Sarah test	4/27/2023	37.755528	-122.484954
pine valley depressional	depression	smaller dep within larger upland field, 6 photos	5/1/2023	32.837305	-116.531687
			5/1/2023	32.837147	-116.531943
1,3	riverine	ravine channel plus narrow floodplain	5/1/2023	32.863933	-116.517943
1,4	seep	willow and Juncus from break in slope	5/1/2023	32.868251	-116.517623
1,4	riverine	active channel width	5/1/2023	32.870051	-116.517048
1,5	seep	wild rye, water	5/1/2023	32.861747	-116.611426
1,6	riparian zone	not sure if you map floodplain riparian	5/1/2023	32.869886	-116.609014

1,7	riverine floodplain and riparian	map the riparian?	5/1/2023	32.911065	-116.573973
1,7	possible slope	Junius, willow, snobbery and rose	5/1/2023	32.914383	-116.567086
1,8	forested floodplain	Willows with grass understory	5/1/2023	32.92433	-116.55959
1,9	wet meadow	upper, carex Junius nettle	5/1/2023	32.961412	-116.582652
2,1	depression	can't find drainage out	5/2/2023	33.608304	-117.758471
2,7	depressional	3 individual basins	5/2/2023	33.595629	-117.724928
fake 001	fake	test	4/27/2023	32.803531	-116.936878
1,14	depression	county of San Diego duck pond	5/2/2023	32.820974	-116.976801
3,5	depressional forested	Cottonwood and willow	5/3/2023	32.909563	-117.206231
3,5	depressional emergent	mulefat juncus	5/3/2023	32.909248	-117.206455
3,2	depressional	has island in middle of right hand blob. unnatural	5/3/2023	32.80019	-117.216686
4,7	riverine forested	if map poly it should be this wide	5/4/2023	33.323444	-117.156668
4,7	riverine	forested floodplain, likely slope wetland	5/4/2023	33.325103	-117.15715

4,1	depressional	pond in garden with waterfall	5/4/2023	33.481088	-117.122318
4,3	riverine	poly? it's a mowed flood control channel floodplain bench	5/4/2023	33.506944	-117.159167
4,5	riverine	channel with wider wet area rumex. Has stormwater pipes feeding from above	5/4/2023	33.591887	-117.126324
5,1	forested slope	channel and wetland floodplain. POLY DOES NOT include trees on the slope. should be blueline and poly	5/5/2023	33.040817	-117.088061
5,3	depressional	small channel and road culvert feeding. mulefat, baccharis, willow baby syc	5/5/2023	33.055338	-117.073607
5,4	slope wet meadow	Bermuda, rabbits, Rumer, anamopsis, cattail	5/5/2023	33.081567	-117.083433
5,4	forested slope	widen to the road	5/5/2023	33.079736	-117.084046
5,9	depressional	berm, drain, juncus, willow, tamarisk,	5/5/2023	33.141818	-117.023743

6,3	depressional	a pocket of dep within upland	5/8/2023	32.61653	-117.09407
6,3	depressional	pocket of dep within upland	5/8/2023	32.61579	-117.095743
7,1	depressional	detention basin, looks new with development of ymca	5/9/2023	32.704476	-117.098226
7,2	forested slope	example of width	5/9/2023	32.673291	-117.021716
7,6	slope emergent	eleocharis, carex willow	5/9/2023	32.600685	-116.93142
7,9	depressional	just the lowest	5/9/2023	32.568107	-116.940761
8,5	forested slope	willow po carex soft chess bromus diandrus Italian rye	5/10/2023	32.823322	-116.625998
8,5	upland	swale.	5/10/2023	32.823017	-116.624758
8,6	slope emergent	juncus spot	5/10/2023	32.827392	-116.622289
8,6	slope emergent	juncus soft chess lupine	5/10/2023	32.828156	-116.622016
8,6	slope emergent	juncus	5/10/2023	32.828696	-116.621497
8,6	slope emergent	all at breaks in slope	5/10/2023	32.829798	-116.622094
8,6	slope emergent		5/10/2023	32.830285	-116.622363
8,10	slope emergent	juncus carex	5/10/2023	32.716579	-116.469603
8,10	slope emergent	we think this is likely wet enough	5/10/2023	32.711283	-116.471846
8,10	upland	this is showing pretty dry	5/10/2023	32.715895	-116.466777

8,2	riverine	multi thread channel with tamarisk	5/10/2023	32.770633	-116.882128
8,2	riverine	example width	5/10/2023	32.771966	-116.883914

Appendix C. SDARI to CARI Crosswalk

Table 8. *A crosswalk between the SDARI classification schema and CARI.*

orig_class	Wetland_Type	CARI Clickcode	CARI Clicklabel	CARI LegLabel Level 1	CARI LegLabel Level 2
Channel Natural	Channel	WRNRnnu	Riverine Natural	Fluvial Channel	Fluvial Channel
Channel Unnatural	Channel	WRURnnu	Riverine Unnatural Non-vegetated	Fluvial Channel	Fluvial Channel
Channel Vegetated Woody Natural	Channel Forested	WRNRnnF	Riverine Natural Forested	Riverine Vegetated	Riverine Vegetated
Channel Vegetated Natural	Channel Vegetated	WRNRnnv	Riverine Natural Vegetated	Riverine Vegetated	Riverine Vegetated
Bay	Bay	OENESSN	Estuarine Saline Natural Subtidal Non-vegetated	Subtidal Water	Estuarine Subtidal
Depressional Open Water Natural	Depressional Open Water	ODNDuuN	Depressional Natural Non-vegetated	Pond and associated vegetation	Depressional
Depressional Open Water Unnatural	Depressional Open Water	ODUDuuN	Depressional Unnatural Non-vegetated	Pond and associated vegetation	Depressional
Depressional Vegetated Natural	Depressional Vegetated	WDNDuuv	Depressional Natural Vegetated	Pond and associated vegetation	Depressional

Depressional Vegetated Unnatural	Depressional Vegetated	WDUDuuv	Depressional Unnatural Vegetated	Pond and associated vegetation	Depressional
Lacustrine Open Water Natural	Lacustrine Open Water	OLNLnuu	Lacustrine Natural	Lake, Reservoir and associated vegetation	Lacustrine
Lacustrine Open Water Unnatural	Lacustrine Open Water	OLULnuu	Lacustrine Unnatural	Lake, Reservoir and associated vegetation	Lacustrine
Lacustrine Vegetated Natural	Lacustrine Vegetated	WLNLnuv	Lacustrine Natural Vegetated	Lake, Reservoir and associated vegetation	Lacustrine
Lacustrine Vegetated Unnatural	Lacustrine Vegetated	WLULnuv	Lacustrine Unnatural Vegetated	Lake, Reservoir and associated vegetation	Lacustrine
Lagoon Perennial Open Water Unnatural	Lagoon Open Water	OGUGnuN	Lagoon Unnatural Non-vegetated	Pond	Estuarine Pond
Tidal Channel Natural	Tidal Channel	ORNRTSN	Riverine Natural Subtidal Open Water	Subtidal Water	Estuarine Subtidal
Tidal Flat	Tidal Flat	WENESIN	Estuarine Saline Natural Intertidal Non-vegetated	Tidal Flat and Marsh Panne	Estuarine Intertidal
Tidal Pond/Panne Natural	Tidal Marsh Panne	WENENIN	Estuarine Non-saline Natural Intertidal Non-vegetated	Tidal Flat and Marsh Panne	Estuarine Intertidal

Tidal Vegetated Natural	Tidal Vegetated	WENENIv	Estuarine Non-saline Natural Intertidal Vegetated	Tidal Marsh	Estuarine Intertidal Vegetated
Vernal Pool Natural	Vernal Pool	WDNVInu	Vernal Pool Individual	Vernal Pool	Vernal Pool
Wet Meadow Natural	Wet Meadow Slope	WSNSWuH	Slope Natural Wet Meadow Herbaceous	Slope and Seep Wetlands	Forested Slopes, Wet Meadows, and Seeps
Woody Slope Natural	Woody Slope	WSNSFuF	Slope Natural Forested	Slope and Seep Wetlands	Forested Slopes, Wet Meadows, and Seeps
Woody Slope Unnatural	Woody Slope	WSUSFuF	Slope Unnatural Forested	Slope and Seep Wetlands	Forested Slopes, Wet Meadows, and Seeps

Appendix D. SDARI to NWI Crosswalk

Table 9. *A crosswalk between the SDARI classification schema and NWI.*

Wetland_Type	NWI Code
Bay	E1UBL
Tidal Vegetated	E2EM1N
Tidal Channel	E2SB5N
Tidal Flat	E2US3N
Tidal Marsh Panne	E2US3N
Vernal Pool	PEM1A
Channel	R2UBH
Channel	R2UBHx
Channel Forested	PSS1C

Channel Forested	PSS1C
Channel Vegetated	PEM1C
Depressional Open Water	PUB3H
Depressional Open Water	PUB3Hx
Depressional Vegetated	PEM1C
Depressional Vegetated	PEM1Cx
Lacustrine Open Water	L1UBH
Lacustrine Open Water	L1UBHh
Lacustrine Vegetated	L2EM2F
Lacustrine Vegetated	L2EM2Fh
Lagoon Open Water	E2USNh
Wet Meadow Slope	PEM1A
Wet Meadow Slope	PEM1A
Woody Slope	PSS1A
Woody Slope	PSS1A

Appendix E. Accuracy Assessment

Table 10. Fuzzy Error Matrix Showing Both Deterministic and Fuzzy Accuracy Assessment

MAPPED DATA / REFERENCE DATA

MAPPED DATA	Bay	Channel	Channel Forested	Channel Vegetated	Depressional Open Water	Depressional Vegetated	Lacustrine Open Water	Lacustrine Vegetated	Lagoon Open Water	Not Wetland	Tidal Channel	Tidal Flat	Tidal Pond/ Panne	Tidal Vegetated	Vernal Pool	Wet Meadow Slope	Woody Slope	User's Accuracies: Deterministic Totals	Percent Deterministic	Fuzzy Totals	Percent Fuzzy
Bay	**78**	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	78/80	97.5%	78/80	97.5%
Channel	0,0	**34**	1,0	2,2	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	34/40	85.0%	37/40	92.5%
Channel Forested	0,0	0,0	**28**	1,0	0,0	1,0	0,0	0,0	0,0	3,4	0,0	0,0	0,0	0,0	0,0	0,2	0,1	28/40	70.0%	33/40	82.5%
Channel Vegetated	0,0	1,0	20,0	**14**	0,0	0,1	0,0	0,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0	2,1	14/40	35.0%	38/40	95.0%
Depressional Open Water	0,0	0,0	0,0	0,0	**35**	0,3	0,0	0,0	0,0	1,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	35/40	87.5%	36/40	90.0%
Depressional Vegetated	0,0	0,0	1,1	0,1	0,2	**16**	0,0	0,5	0,0	4,3	0,0	0,0	0,0	0,0	0,0	1,1	1,1	16/37	43.2%	23/37	62.2%
Lacustrine Open Water	0,0	0,0	0,0	0,0	0,0	0,0	**37**	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,2	0,0	37/40	92.5%	37/40	92.5%
Lacustrine Vegetated	0,0	0,1	1,1	0,4	0,0	0,4	1,0	**21**	0,0	1,2	0,0	0,0	0,0	0,0	0,0	4,3	1,0	21/44	47.7%	29/44	65.9%
Lagoon Open Water	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**40**	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	40/40	100.0%	40/40	100.0%
Not Wetland	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**38**	0,0	0,0	0,0	0,0	0,0	1,0	1,0	38/41	92.7%	40/41	97.6%
Tidal Channel	2,10	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	**18**	3,5	0,0	2,2	0,0	0,0	0,0	18/43	41.9%	25/43	58.1%
Tidal Flat	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,3	1,0	**17**	1,1	2,12	0,0	0,0	0,0	17/37	45.9%	21/37	56.8%
Tidal Pond/Panne	0,0	0,0	0,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0	1,6	0,0	**26**	2,3	0,0	0,0	0,0	26/39	66.7%	30/39	76.9%
Tidal Vegetated	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,1	0,0	0,1	1,3	**32**	0,0	1,0	0,0	32/40	80.0%	35/40	87.5%
Vernal Pool	0,0	0,0	0,0	0,0	4,2	0,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**29**	0,0	0,1	29/40	72.5%	33/40	82.5%
Wet Meadow Slope	0,0	0,1	0,1	3,0	0,0	0,0	0,0	0,0	0,0	1,1	0,0	0,0	0,0	1,0	0,0	**32**	0,0	32/40	80.0%	37/40	92.5%
Woody Slope	0,0	0,0	10,0	2,3	0,0	1,2	0,0	0,0	0,0	1,1	0,0	0,0	0,0	0,0	0,0	1,1	**18**	18/40	45.0%	33/40	82.5%
Producer's Accuracies																					
Deterministic Totals	78/90	34/38	28/64	14/32	35/44	16/32	37/38	21/28	40/40	38/70	18/26	17/26	26/32	32/56	29/29	32/49	18/27				
Percent Deterministic	86.7%	89.5%	43.8%	43.8%	79.5%	50.0%	97.4%	75.0%	100%	54.3%	69.2%	65.4%	81%	57%	100%	65.3%	66.7%				
Fuzzy Totals	80/90	35/38	61/64	22/32	40/44	18/32	38/38	21/28	40/40	51/70	20/26	20/26	28/32	39/56	29/29	40/49	23/27				
Percent Fuzzy	88.9%	92.1%	95.3%	68.8%	90.9%	56.3%	100.0%	75.0%	100.0%	72.9%	76.9%	76.9%	87.5%	69.6%	100%	81.6%	85.2%				

Overall Accuracies

Deterministic		Fuzzy	
513 / 721	**71%**	605 / 721	**84%**