Monitoring Category	Management Questions	Monitoring Questions	Products/Indicators	Metrics	Approach and Methods	Geospatial Portal Data Label
Regional-Scale Monitoring Activities	1A, 1B	What is the distribution and abundance of the estuary's tidal wetlands and other baylands, including within restoration projects?	Map of bayland habitats and landscape features (tidal marsh, channels, mudflats, ponds/pannes, etc.)	Acres and locations of habitat types and landscape features	WRMP Geospatial SOP: Regional Habitat Map	Habitat
Regional-Scale Monitoring Activities	1A, 3A	What are the elevations of the estuary's existing and restoring tidal wetlands? What is their elevation capital?	Map of bayland elevations and elevation capital	Elevations (ft NAVD) and elevation capital (Z*); relative to local MHHW)	WRMP Geospatial SOP: Regional Elevation Map	Elevation and Geomorphology
Regional-Scale Monitoring Activities		Where do tidal wetlands have space to migrate upslope?	Map of estuarine-terrestrial transition zones and migration space.	Elevations (ft NAVD) and elevation capital (Z*); relative to local MHHW)		
Regional-Scale Monitoring Activities	1A	What is the current distribution, extent, and diversity of dominant vegetation communities in the estuary?	Map of tidal wetland vegetation alliances	Acres and location of dominant tidal wetland vegetation alliances	WRMP Vegetation SOP: Regional Vegetation Map	Vegetation
Regional-Scale Monitoring Activities	1A	Where do tidal wetlands support complex habitat diversity and connectivity?	Map of "complete marshes" as defined by BEHGU and fluvial/upland/riparian connectivity.	Acres and location of marshes with connectivity to estuarine-terrestrial transition zones, mudflats, and channels	Derivative of regional habitat map	Habitat
Regional-Scale Monitoring Activities	1A	Where do tidal wetlands support complex habitat diversity and connectivity?	Maps of baylands resilience metrics	See Baylands Resilience Framework: https://www.sfei.org/node/8356	Derivative of regional habitat and elevation maps	Habitat
Regional-Scale Monitoring Activities	1A	Where do tidal wetlands have space to migrate upslope?	Map of estuarine-terrestrial transition zones and migration space.	See Baylands Resilience Framework: https://www.sfei.org/node/8357	Derivative of regional habitat and elevation maps	Habitat

NOTE: This September 2024 version of the Monitoring Matrix was developed for inclusion in the WRMP Monitoring Plan, and reflects updates to the science framework made throughout 2023 and early 2024.

Monitoring Category	Management Questions	Monitoring Questions	Products/Indicators	Metrics	Approach and Methods	Geospatial Portal Data Label
Regional-Scale Monitoring Activities	1A, 3A	Where are unvegetated areas such as channels, ponds, and pannes expanding?	Changes in drainage network length, channel density, channel width, numbers and sizes of pannes, size of un-vegetated areas of tidal marsh plains.	Drainage network length, channel density, channel width, numbers and sizes of pannes, size of un-vegetated areas of tidal marsh plains.	Derivative of regional habitat map	Elevation and Geomorphology
Regional-Scale Monitoring Activities	1A, 4A	What is the distribution and abundance of tidal wetland habitats that can support special-status species?	Map of tidal wetland special-status species habitats.	Acres and locations of habitat types that could support special-status species.	Derivative of regional habitat, elevation, and vegetation maps	Habitat
Regional-Scale Monitoring Activities	1A	Where are shorelines eroding landward and/or growing seaward?	Map of changes in the lateral extents of natural foreshores (tidal marsh and beach).	Shoreline location	SOP from Beagle et al. 2015 and SFEI and Baye 2020	Elevation and Geomorphology
Regional-Scale Monitoring Activities	1A	What are the rates of change over time in the spatial extent and distribution of dominant vegetation communities along the primary and secondary salinity gradients of the estuary?	Direction and magnitude of changes in tidal wetland vegetation alliances	Change in acres and location of dominant tidal wetland vegetation alliances	Derivative of regional vegetation map	Vegetation
Regional-Scale Monitoring Activities	1A	Where are non-native species a significant component of the dominant tidal wetland vegetation community? Where are they expanding?	Distribution and abundance of selected non-native, invasive plant species.	Acres and locations of selected non-native/invasive bayland vegetation alliances	Derivative of regional vegetation map	Vegetation
Regional-Scale Monitoring Activities	1A	What is the distribution and abundance of tidal marsh mosquito habitats?	Distribution and abundance of potential mosquito breeding areas	Total area and patch size of known and potential areas of mosquito production	TBD	Habitat

Monitoring Category	Management Questions	Monitoring Questions	Products/Indicators	Metrics	Approach and Methods	Geospatial Portal Data Label
Subregional-Scale Monitoring Activities	2B	Where is there adequate suspended sediment to support rates of accretion that are equal to or greater than sea level rise (SLR)?	Spatial and temporal trends of SCC in tidal channels in relation to watershed yields of SS and SSC in estuarine shallows and bays.	Turbidity calibrated to suspended sediment concentrations in key feeder channels to existing and restoring tidal marshes	WRMP Hydrogeomorphic SOP: Turbidity/SSC	Water Quality
Subregional-Scale Monitoring Activities	3A	How do tidal inundation regimes differ throughout the estuary's tidal baylands (marshes + channels), and are they muted, choked, or otherwise different from source tides?	Spatial and temporal trends in the frequency, duration, and depth of tidal inundation of tidal baylands (marshes + channels).	Tidal inundation regime	WRMP Hydrogeomorphic SOP: Water Surface Elevations + Sea Level Rise	Hydrology
Subregional-Scale Monitoring Activities	3A	What are the regional rates of sea level rise and how do they vary throughout the estuary?	Spatial and temporal trends in the rate of sea level rise.	Annual mean sea level rise.	WRMP Hydrogeomorphic SOP: Water Surface Elevations + Sea Level Rise	Hydrology
Subregional-Scale Monitoring Activities	4A	How do surface water salinity fields differ throughout the estuary's tidal baylands, and how are they changing over time?	Spatial and temporal trends in the surface water salinity of tidal baylands (marshes + channels).	Surface water salinity	WRMP Hydrogeomorphic SOP: Surface Water Salinity	Water Quality
Site-Scale Monitoring Activities	1A, 4A	How do tidal bayland morphology and vegetation qualitatively change over time?	Time series of photographs from photopoints	Observable changes in intertidal geomorphology and vegetation communities	WRMP Hydrogeomorphic SOP: Photopoints	Vegetation
Site-Scale Monitoring Activities	4A	How do porewater salinity fields differ throughout the estuary's tidal wetlands?	Spatial and temporal trends in the porewater salinity of select tidal baylands (marshes).	Porewater salinity	WRMP Hydrogeomorphic SOP: Porewater salinity	Water Quality

Monitoring Category	Management Questions	Monitoring Questions	Products/Indicators	Metrics	Approach and Methods	Geospatial Portal Data Label
Site-Scale Monitoring Activities	4B	Where do tidal wetlands and channels provide adequate water quality to support fish and other aquatic life?	DO in tidal marsh channels.	DO concentrations	TBD	Water Quality
Site-Scale Monitoring Activities	4B	Where do tidal wetlands and channels provide adequate water quality to support fish and other aquatic life?	Mercury loading into tidal marsh food webs.	TBD by TAC upon further discussion of how age of marsh (developmental stage of projects), drought, and deluge affect Hg loading into marsh foodwebs, such that it can promulgate objectives or narrative guidance for project performance	TBD by TAC upon further discussion of how age of marsh (developmental stage of projects), drought, and deluge affect Hg loading into marsh foodwebs, such that it can promulgate objectives or narrative guidance for project performance	Water Quality
Site-Scale Monitoring Activities	1A	What is the overall condition and health of the estuary's tidal wetlands?	CRAM site scores and regional Cumulative Distribution Functions (CDFs).	CRAM Index and Metric scores relative to regional CRAM CDFs	CRAM assessments using the CRAM SOP	CRAM
Site-Scale Monitoring Activities	2A	What are the elevations of tidal baylands, how are they changing over time, and where in the estuary are tidal wetland accretion rates keeping up with rates of sea level rise?	Spatial and temporal trends in tidal bayland vertical change and accretion rates.	Changes in tidal bayland elevations relative to local tidal datums and NAVD	WRMP Hydrogeomorphic SOP: Elevations	Elevation and Geomorphology

Monitoring Category	Management Questions	Monitoring Questions	Products/Indicators	Metrics	Approach and Methods	Geospatial Portal Data Label
Site-Scale Monitoring Activities	4A	What are the status and trends of percent cover/height/patch characteristics of vegetation across key site- and network-scale hydrogeomorphic gradients (e.g. elevation, inundation, salinity)?	Percent cover/height patch characteristics of vegetation compared to hydrogeomorphic indicators	TBD; likely to include acres and location of dominant tidal wetland vegetation alliances, patchiness, total % cover, veg height, etc.	WRMP Vegetation SOP: Field Monitoring of Vegetation Communities	Vegetation
Site-Scale Monitoring Activities	4B	What are the long-term trends in the estuary's tidal wetland fish communities?	Rare fish taxa: presence/absence; common fish taxa: abundance/density/biomass/cpue, diversity and community structure, trophic/age/size structure	Rare fish taxa: presence/absence; common fish taxa: abundance/density/biomass/cpue, diversity and community structure, trophic/age/size structure	WRMP FFH SOP	Fish
Site-Scale Monitoring Activities	4B	Are the region's tidal wetlands and tidal wetland restoration projects contributing to the recovery of listed fish species?	Rare fish taxa: presence/absence; common fish taxa: abundance/density/biomass/cpue, diversity and community structure, trophic/age/size structure	Rare fish taxa: presence/absence; common fish taxa: abundance/density/biomass/cpue, diversity and community structure, trophic/age/size structure	WRMP FFH SOP	Fish
Site-Scale Monitoring Activities		How can the estuary's tidal wetlands and tidal wetland restoration projects be adaptively managed to support rare and common fish taxa?	Rare fish taxa: presence/absence; common fish taxa: abundance/density/biomass/cpue, diversity and community structure, trophic/age/size structure	Rare fish taxa: presence/absence; common fish taxa: abundance/density/biomass/cpue, diversity and community structure, trophic/age/size structure	WRMP FFH SOP	Fish
Site-Scale Monitoring Activities	4B	TBD by bird workgroup/State of the Birds	TBD by bird workgroup/State of the Birds	TBD by bird workgroup/State of the Birds	TBD by bird workgroup/State of the Birds	Birds
Site-Scale Monitoring Activities	4B	TBD by mammal workgroup	TBD by mammal workgroup	TBD by mammal workgroup	TBD by mammal workgroup	Mammals

Monitoring Category	Management Questions	Monitoring Questions	Products/Indicators	Metrics	Approach and Methods	Geospatial Portal Data Label
Site-Scale Monitoring Activities	5A, 5B	What is the production of mosquitoes by tidal marshes?	Mosquito production	Counts of mosquito adults and larvae by species	TBD	Habitat
People & Wetlands Monitoring Activities	5C	At wetland sites where public access is allowed, what are levels, types, and demographics of usage?	Spatial and temporal trends in visitation estimates, visitor origins, reasons for visiting, and demographics	# of visitors (summarized by subregion), visitor demographics vs Bay Area resident demographics	Initially, existing data from East Bay Parks (& other park districts). Later data TBD by workgroup (possibly surveys at select wetland sites or cell phone tracking data)	Human Dimensions
People & Wetlands Monitoring Activities	5C	To what degree are communities and Tribes involved in wetland stewardship, learning, and engagement activities, and what are the demographics of those involved?	Temporal trends in projects following better practices for community & Tribal outreach and partnerships	% of projects reporting public meetings, % of projects reporting targeted outreach strategy, % of projects with funding allocated to community or Tribal partners	Reported to funders as part of proposals or final reports	Human Dimensions
People & Wetlands Monitoring Activities		To what degree are communities and Tribes involved in wetland stewardship, learning, and engagement activities, and what are the demographics of those involved?	Temporal trends in representative participation in stewardship and education events/programs	#s of annual participants, participant demographics vs Bay Area resident demographics	Reported to funders or WRMP by programs (Save the Bay, Grassroots Ecology, etc.)	Human Dimensions

Monitoring Category	Management Questions	Monitoring Questions	Products/Indicators	Metrics	Approach and Methods	Geospatial Portal Data Label
People & Wetlands Monitoring Activities		To what degree are communities and Tribes involved in wetland stewardship, learning, and engagement activities, and what are the demographics of those involved?	Temporal trends in proportion of wetland decision-makers from underrepresented groups	% of restoration practitioners & committee members representing EJ communities or Tribes, % of restoration practitioners & committee members identifying as people of color or other underrepresented identities	Survey distributed to established committees (e.g. WRMP, SFBRA, SFBJV) & restoration practitioners (e.g. project managers of funded projects)	Human Dimensions
People & Wetlands Monitoring Activities		Multiple (see Monitoring Qs for flood protection, access, water quality)	Map of existing and potential wetland restoration projects for flood protection, water quality improvement, wildlife habitat, and public access, overlaid with EJ map	% of total projects providing each benefit for EJ and non-EJ communities	Restoration project data (SFBRA; later addition of Project Tracker data); EJ map TBD	Human Dimensions
People & Wetlands Monitoring Activities	5B, 5C	What level of flood risk reduction are wetlands and wetland projects providing to nearby communities around the estuary? How do levels of flood risk reduction from wetlands vary between EJ communities and other communities?	Map of wetland wave attenuation metrics (modeled capacity to attenuate waves), overlaid with EJ map		Bayland resilience metrics (SFEI; derivative of Indicator 1); EJ map TBD	Human Dimensions
People & Wetlands Monitoring Activities	5B, 5C	How is wetland access, including quality of access, distributed around the estuary? How does access vary between EJ communities and other communities?	Map of wetlands with nearby public access and key amenities/features, overlaid with EJ map	Trail miles (or density) and amenities score for wetlands or wetland-adjacent shorelines near EJ and non-EJ communities	BCDC permitted trails map, Bay Trail map, amenities & features on OpenStreetMap (and other publicly-available sources); EJ map TBD	Human Dimensions

Monitoring Category	Management Questions	Monitoring Questions	Products/Indicators	Metrics	Approach and Methods	Geospatial Portal Data Label
People & Wetlands Monitoring Activities	5C	How does water quality in wetlands proximate to EJ communities compare with water quality in wetlands proximate to other communities?	Map of basic water quality metrics (dissolved oxygen) and nearshore sediment contaminants, overlaid with EJ map	Proportion of sites falling into categories (low/poor, moderate/fair, high/good) for EJ and non-EJ communities	Bay RMP nearshore sediment contaminant data, future WRMP-collected basic water quality data	Human Dimensions