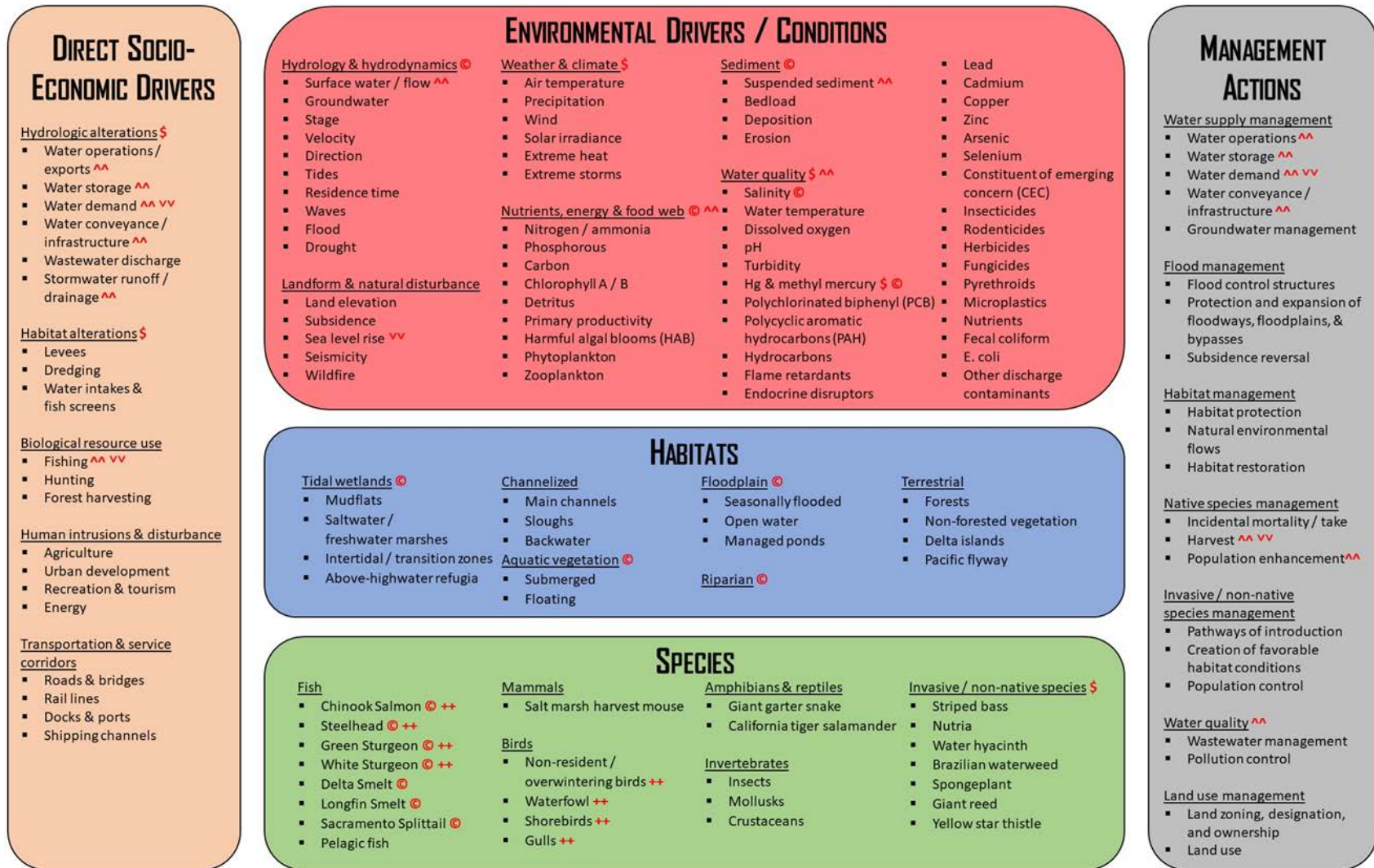# Monitoring Inventory Framework (8/19/19)

Below is a diagram of the conceptual framework for representing the biological, physical, chemical, and socio-economic components of relevance for the Delta Independent Science Board's review of the monitoring enterprise.

DIRECT SOCIO-ECONOMIC DRIVERS

Hydrologic alterations $
- Water operations / exports ^^
- Water storage ^^
- Water demand ^^ vv
- Water conveyance / infrastructure ^^
- Wastewater discharge
- Stormwater runoff / drainage ^^

Habitat alterations $
- Levees
- Dredging
- Water intakes & fish screens

Biological resource use
- Fishing ^^ vv
- Hunting
- Forest harvesting

Human intrusions & disturbance
- Agriculture
- Urban development
- Recreation & tourism
- Energy

Transportation & service corridors
- Roads & bridges
- Rail lines
- Docks & ports
- Shipping channels

ENVIRONMENTAL DRIVERS / CONDITIONS

Hydrology & hydrodynamics ©
- Surface water / flow ^^
- Groundwater
- Stage
- Velocity
- Direction
- Tides
- Residence time
- Waves
- Flood
- Drought

Landform & natural disturbance
- Land elevation
- Subsidence
- Sea level rise vv
- Seismicity
- Wildfire

Weather & climate $
- Air temperature
- Precipitation
- Wind
- Solar irradiance
- Extreme heat
- Extreme storms

Nutrients, energy & food web © ^^
- Nitrogen / ammonia
- Phosphorous
- Carbon
- Chlorophyll A / B
- Detritus
- Primary productivity
- Harmful algal blooms (HAB)
- Phytoplankton
- Zooplankton

Sediment ©
- Suspended sediment ^^
- Bedload
- Deposition
- Erosion

Water quality $ ^^
- Salinity ©
- Water temperature
- Dissolved oxygen
- pH
- Turbidity
- Hg & methyl mercury $ ©
- Polychlorinated biphenyl (PCB)
- Polycyclic aromatic hydrocarbons (PAH)
- Hydrocarbons
- Flame retardants
- Endocrine disruptors

- Lead
- Cadmium
- Copper
- Zinc
- Arsenic
- Selenium
- Constituent of emerging concern (CEC)
- Insecticides
- Rodenticides
- Herbicides
- Fungicides
- Pyrethroids
- Microplastics
- Nutrients
- Fecal coliform
- E. coli
- Other discharge contaminants

HABITATS

Tidal wetlands ©
- Mudflats
- Saltwater / freshwater marshes
- Intertidal / transition zones
- Above-highwater refugia

Channelized
- Main channels
- Sloughs
- Backwater

Aquatic vegetation ©
- Submerged
- Floating

Floodplain ©
- Seasonally flooded
- Open water
- Managed ponds

Riparian ©

Terrestrial
- Forests
- Non-forested vegetation
- Delta islands
- Pacific flyway

SPECIES

Fish
- Chinook Salmon © ++
- Steelhead © ++
- Green Sturgeon © ++
- White Sturgeon © ++
- Delta Smelt ©
- Longfin Smelt ©
- Sacramento Splittail ©
- Pelagic fish

Mammals
- Salt marsh harvest mouse

Birds
- Non-resident / overwintering birds ++
- Waterfowl ++
- Shorebirds ++
- Gulls ++

Amphibians & reptiles
- Giant garter snake
- California tiger salamander

Invertebrates
- Insects
- Mollusks
- Crustaceans

Invasive / non-native species $
- Striped bass
- Nutria
- Water hyacinth
- Brazilian waterweed
- Spongeplant
- Giant reed
- Yellow star thistle

MANAGEMENT ACTIONS

Water supply management
- Water operations ^^
- Water storage ^^
- Water demand ^^ vv
- Water conveyance / infrastructure ^^
- Groundwater management

Flood management
- Flood control structures
- Protection and expansion of floodways, floodplains, & bypasses
- Subsidence reversal

Habitat management
- Habitat protection
- Natural environmental flows
- Habitat restoration

Native species management
- Incidental mortality / take
- Harvest ^^ vv
- Population enhancement ^^

Invasive / non-native species management
- Pathways of introduction
- Creation of favorable habitat conditions
- Population control

Water quality ^^
- Wastewater management
- Pollution control

Land use management
- Land zoning, designation, and ownership
- Land use

Note the use of the following abbreviations: $ denotes primary stressors on the Delta, © denotes components with readily available conceptual models, ^^ (double caret) denote components with upstream drivers / stressors that influence the Delta, vv (double circumflex) denote components with downstream drivers / stressors that influence the Delta, and ++ denote non-resident species that use the Delta for a portion of their life cycle.

Alternative Format: Monitoring Inventory Framework

An alternative format of the conceptual framework for the monitoring inventory is below that describes the different components of the inventory in list format. The different components of the framework include (1) direct socio-economic drivers, (2) environmental drivers/conditions, (3) habitats, (4) species, and (5) management actions.

Note the use of the following abbreviations:

- U = components with upstream drivers or stressors that influence the Delta
- D = components with downstream drivers or stressors that influence the Delta
- P = primary stressors in Delta
- C = components with readily available conceptual models
- M = non-resident species that use the Delta for a portion of life cycle

Direct Socio-Economic Drivers

Hydrologic alterations

- Water operations / exports (U)
- Water conveyance / infrastructure (U)
- Water storage (U)
- Wastewater discharge
- Water demand (U, D)
- Stormwater runoff / drainage (U)

Habitat alterations

- Levees
- Water intakes & fish screens
- Dredging

Biological resource use

- Fishing (U, D)
- Forest harvesting
- Hunting

Human intrusions & disturbance

- Agriculture
- Recreation & tourism
- Urban development
- Energy

Transportation & service corridors

- Roads & bridges
- Docks & ports
- Rail lines
- Shipping channels

Environmental Drivers/Conditions

Hydrology & hydrodynamics (C)

- Surface water / flow (U)
- Tides
- Groundwater
- Residence time
- Stage
- Waves
- Velocity
- Flood
- Direction
- Drought

Landform & natural disturbance

- Land elevation
- Seismicity
- Subsidence
- Wildfire
- Sea level rise (D)

Weather & climate

- Air temperature
- Solar irradiance
- Precipitation
- Extreme heat
- Wind
- Extreme storms

Nutrients, energy & food web (C, U)

- Nitrogen / ammonia
- Primary productivity
- Phosphorous
- Harmful algal blooms
- Carbon
- Phytoplankton
- Chlorophyll A / B
- Zooplankton
- Detritus

Sediment (C)

- Suspended sediment (U)
- Bedload
- Deposition
- Erosion

Water quality (P, U)

- Salinity (C)
- Zinc
- Water temperature
- Arsenic
- Dissolved oxygen
- Selenium
- pH
- Constituent of emerging concern
- Turbidity
- Insecticides
- Hg & methyl mercury (P, C)
- Rodenticides
- Polychlorinated biphenyl
- Herbicides
- Polycyclic aromatic hydrocarbons
- Fungicides
- Hydrocarbons
- Pyrethroids
- Flame retardants
- Microplastics
- Endocrine disruptors
- Nutrients

- Lead
- Fecal coliform
- Cadmium
- E. coli
- Copper
- Other discharge contaminants

Habitats

Tidal wetlands (C)

- Mudflats
- Intertidal / transition zones
- Saltwater / freshwater marshes
- Above-highwater refugia

Channelized

- Main channels
- Backwater
- Sloughs

Aquatic vegetation (C)

- Submerged
- Floating

Floodplain (C)

- Seasonally flooded
- Managed ponds
- Open water

Riparian (C)

Terrestrial

- Forests
- Delta islands
- Non-forested vegetation
- Pacific flyway

Species

Fish

- Chinook Salmon (C, M)
- Delta Smelt (C)
- Steelhead (C, M)
- Longfin Smelt (C)
- Green Sturgeon (C, M)
- Sacramento Splittail (C)
- White Sturgeon (C, M)
- Pelagic fish

Mammals

- Salt marsh harvest mouse

Birds

- Non-resident / overwintering birds (M)

- Shorebirds (M)
- Waterfowl (M)
- Gulls (M)

Amphibians & reptiles
- Giant garter snake
- California tiger salamander

Invertebrates
- Insects
- Crustaceans
- Mollusks

Invasive / non-native species (P)
- Striped bass
- Brazilian waterweed
- Yellow star thistle
- Spongeplant
- Nutria
- Giant reed
- Water hyacinth

Management Actions

Water supply management
- Water operations (U)
- Water conveyance / infrastructure (U)
- Water storage (U)
- Groundwater management
- Water demand (U, D)

Flood management
- Flood control structures
- Subsidence reversal
- Protection and expansion of floodways, floodplains, & bypasses

Habitat management
- Habitat protection
- Habitat restoration
- Natural environmental flows

Native species management
- Incidental mortality / take
- Population enhancement (U)
- Harvest (U, D)

Invasive / non-native species management
- Pathways of introduction
- Population control
- Creation of favorable habitat conditions

Water quality (U)

- Wastewater management
- Pollution control

Land use management

- Land zoning, designation, and ownership