Table for Mgt. Question #1: What **changes** in estuary, plume and near ocean ecosystem functions, processes and relationships have occurred?

|  |  |  |  |
| --- | --- | --- | --- |
| **Alterations or Changes Have Occurred in:** | **Tidally-influenced Estuary** | **CR Plume** | **Near-shore Ocean** |
| **Physical/Chemical Characteristics** |  |  |  |
| * Upwelling | NA | Y | Y |
| * Acidification | Y | Y | Y |
| * Hypoxia | ? | Y | Y |
| * Temperature | Y | Y | Y |
| * Flow changes | Y | N | N |
| * Sediment changes | Y | Y | NA |
| **Food Web** |  |  |  |
| * Carrying Capacity | ? | Y | Y |
| * Prey Base | Y | Y | Y |
| **Species Interactions** |  |  |  |
| * Predation |  |  |  |
| * Avian | Y- Terns and DCC Abundance has Increased | Y- Murres and Shearwater. Annual variability | Y |
| * Piscivores | Y- pikeminnow | Hake, squid, mackerel species | Hake, squid, mackerel species |
| * Marine mammals | Y- pinnipeds | ? | ? |
| * Competition | Y | Y | Y |
| * Disease/parasites | ? | ? | ? |
| **Characteristics of juvenile salmon** | Y | Y | Y |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

Table for Mgt. Question #2: **Why have changes occurred. Focus on human induced changes (NV= Natural variability)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Why have changes occurred in:** | **Tidally-influenced Estuary** | **CR Plume** | **Near-shore Ocean** |
| **Physical/Chemical Characteristics** |  |  |  |
| * Upwelling | N/A | NV but some evidence it is getting later | NV but some evidence it is getting later |
| * Acidification | Climate change | Climate change | Climate change |
| * Hypoxia | ? | NV | NV |
| * Temperature | Climate change- both FW and Marine.  Water regulation.  NV. | Climate- change both FW and Marine.  Water regulation.  NV | Climate change.  NV- ENSO |
| * Flow changes | NV, Climate, Hydrosystem Operations | NV, Climate, Hydrosystem Operations | NA |
| * Sediment changes | Hydrosystem operations | Hydrosystem operations | NA |
| **Food Web** |  |  |  |
| * Carrying Capacity | Variety of physical drivers including human induced and NV, Invasive Species | Variety of physical drivers including human induced and NV, Invasive Species | Variety of physical drivers including human induced and NV, Invasive Species |
| * Prey Base | Variety of physical drivers including human induced and NV, Invasive Species | Variety of physical drivers including human induced and NV, Invasive Species | Variety of physical drivers including human induced and NV, Invasive Species |
| **Species Interactions** |  |  |  |
| * Predation |  |  |  |
| * Avian | Changes in nesting behavior and habitat | Non-directional change | ? |
| * Piscivorous | Decline in pikeminnow abundance. Increase in non-native species. | Non-directional change in hake and other predator species | ? |
| * Marine mammals | Increase in abundance due to MMPA | ? | ? |
| * Changes in competition | Changes in estuary conditions, variations in abundance of co-occurring fish, changes in non-native species | Changes in ocean/estuary conditions, variations in abundance of co-occurring fish. Changes in non-native species | Changes in ocean conditions, variations in abundance of co-occurring fish. Changes in non-native species |
| * Changes in disease | ? | ? | ? |
| **Characteristics of Juvenile Salmon** | ? | ? | ? |
|  |  |  |  |

Table for Mgt. Question #3: **What are the effects of changes in estuary, plume and the near-shore ocean on ecosystem functions and processes in these ecosystems?**

|  |  |  |  |
| --- | --- | --- | --- |
| **Effects of Alterations or Changes in:** | **Tidally-influenced Estuary** | **CR Plume** | **Near-shore Ocean** |
| **Physical/Chemical Characteristics** |  |  |  |
| * Upwelling | N/A | Changes in DO, Temp,  Food web | Changes in DO, Temp,  Food web |
| * Acidification | Altered plankton community, and attached macrophytes | Altered plankton community | Altered plankton community |
| * Hypoxia | ? | ? | ? |
| * Temperature | Change in accessibility of habitat, changes in survival | Change in availability of habitat, changes in survival | Change in availability of habitat, changes in survival |
| * Flow changes | ? | ? | NA |
| * Sediment changes | ? | ? | NA |
| **Food Web** |  |  |  |
| * Carrying Capacity | ? | ? | ? |
| * Prey Base | ? | ? | ? |
| **Species Interactions** |  |  |  |
| * Predation |  |  |  |
| * Avian | Reduced survival of juvenile salmonids | Reduced survival of juvenile salmonids | Reduced survival of juvenile salmonids |
| * Piscivorous | Reduced survival of juvenile salmonids | Reduced survival of juvenile salmonids | Reduced survival of juvenile salmonids |
| * Marine mammals | Reduced survival of juvenile and adult salmonids. | Reduced survival of juvenile and adult salmonids. | Reduced survival of juvenile and adult salmonids. |
| * Changes in competition | ? | ? | ? |
| * Changes in disease | ? | ? | ? |
| **Characteristics of the Fish** | ? | ? | ? |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

Table for Mgt. Question #4: **What management actions can be taken to improve salmon survival and management effectiveness based on knowledge of estuary, plume and near ocean ecology and dynamics**

|  |  |  |  |
| --- | --- | --- | --- |
| **Alterations or Changes in:** | **Tidally-influenced Estuary** | **CR Plume** | **Near-shore Ocean** |
| **Physical/Chemical Characteristics** |  |  |  |
| * Upwelling | NA | NA | NA |
| * Acidification | Reduce greenhouse gas emissions. | Reduce greenhouse gas emissions. | Reduce greenhouse gas emissions. |
| * Hypoxia | ? | ? | ? |
| * Temperature |  |  |  |
| * Flow changes |  |  |  |
| * Sediment changes |  |  |  |
| **Food Web** |  |  |  |
| * Carrying Capacity |  |  |  |
| * Prey Base |  |  |  |
| **Species Interactions** |  |  |  |
| * Predation |  |  |  |
| * Avian | Reduce avian predation- relocate birds, reduce bird numbers, modify release time | Reduce avian predation | ? |
| * Piscivorous |  |  |  |
| * Marine mammals |  |  |  |
| * Changes in competition |  |  |  |
| * Changes in disease |  |  |  |
| **Characteristics of the Fish** |  |  |  |

Also need to identify whether the changes identified in table are the result of natural variation or are significantly human-induced.

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