U.S. Fish and Wildlife Service
Humboldt Bay National Wildlife Refuge
Humboldt County, California

DRAFT CONCEPT PAPER FOR THE RESTORATION OF TIDAL INFLUENCE TO THE WHITE SLOUGH UNIT, HUMBOLDT BAY NATIONAL WILDLIFE REFUGE

January 2007

PROJECT GOALS

The restoration of the White Slough Unit of Humboldt Bay National Wildlife Refuge (HBNWR) to tidal influence is being conceptually examined. The purpose of this project would be to: 1) Increase the size of the Humboldt Bay estuary and its associated ecological benefits including productivity, wildlife habitat (including anadramous fish and Tidewater goby), biodiversity, flood control, water quality enhancement, and storm energy absorption; 2) Restore declining salt marsh ecosystem and vegetation types, particularly the high elevation mixed marsh type and its associated rare plants; and 3) Determine the cost and demonstrate the feasibility of using fill material to create suitable tidal elevation to encourage native plant communities and discourage invasive *Spartina densiflora*.

SITE DESCRIPTION.

The White Slough Unit encompasses a total of 474 acres, of which 80 acres are either intertidal salt marsh or behind dikes. The remainder consists of intertidal and subtidal mudflats and eelgrass beds. Non-eelgrass vegetation types present include: Brackish marsh (59.6 ac.), salt marsh (10.3 ac.), freshwater swamp/riparian (0.9 ac), freshwater marsh/agricultural wetland (5.7 ac), and upland dike (Fig. 1).

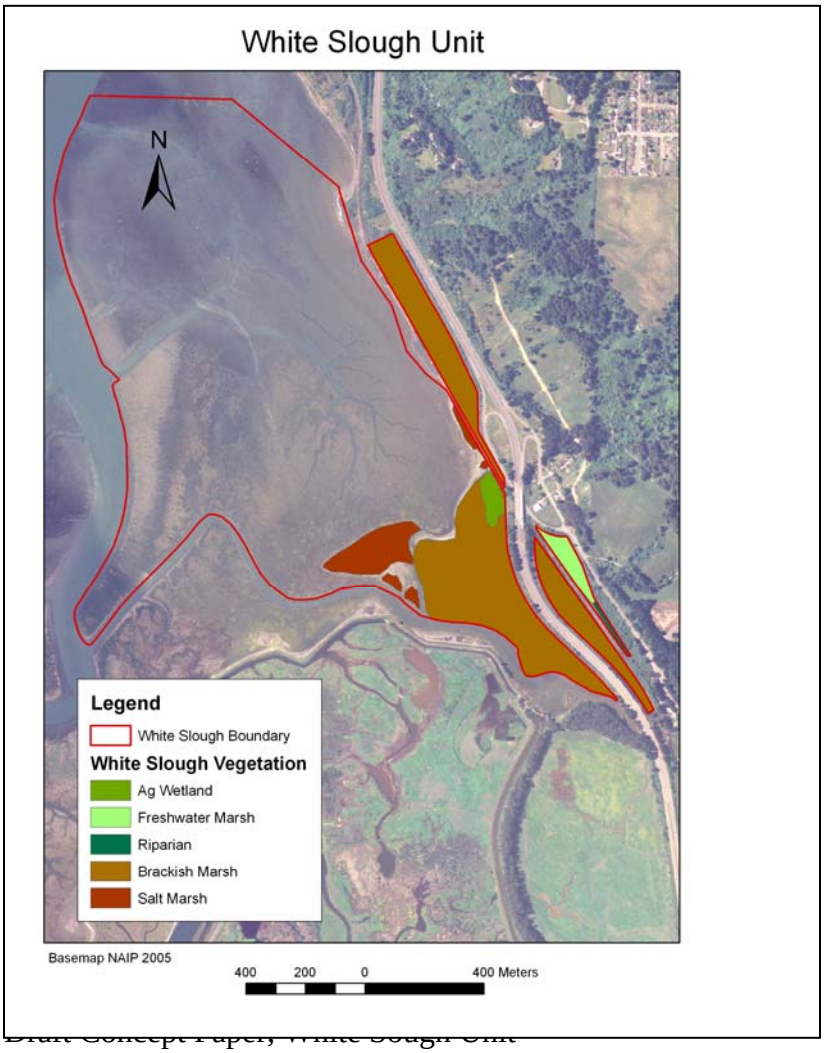

Fig. 1. Map showing Unit boundaries and generalized vegetation types (excluding eelgrass and nonvascular algal beds).

There is currently overtopping of the dikes, and possibly leaking tidegates as well, resulting in the large acreage of brackish marsh. For the purposes of conceptualizing the restoration, the diked area will be subdivided into the northern, western, and eastern subareas (Fig. 2). These are exclusive of the undiked salt marsh areas. Vegetation within these subareas is summarized below (Table 3).

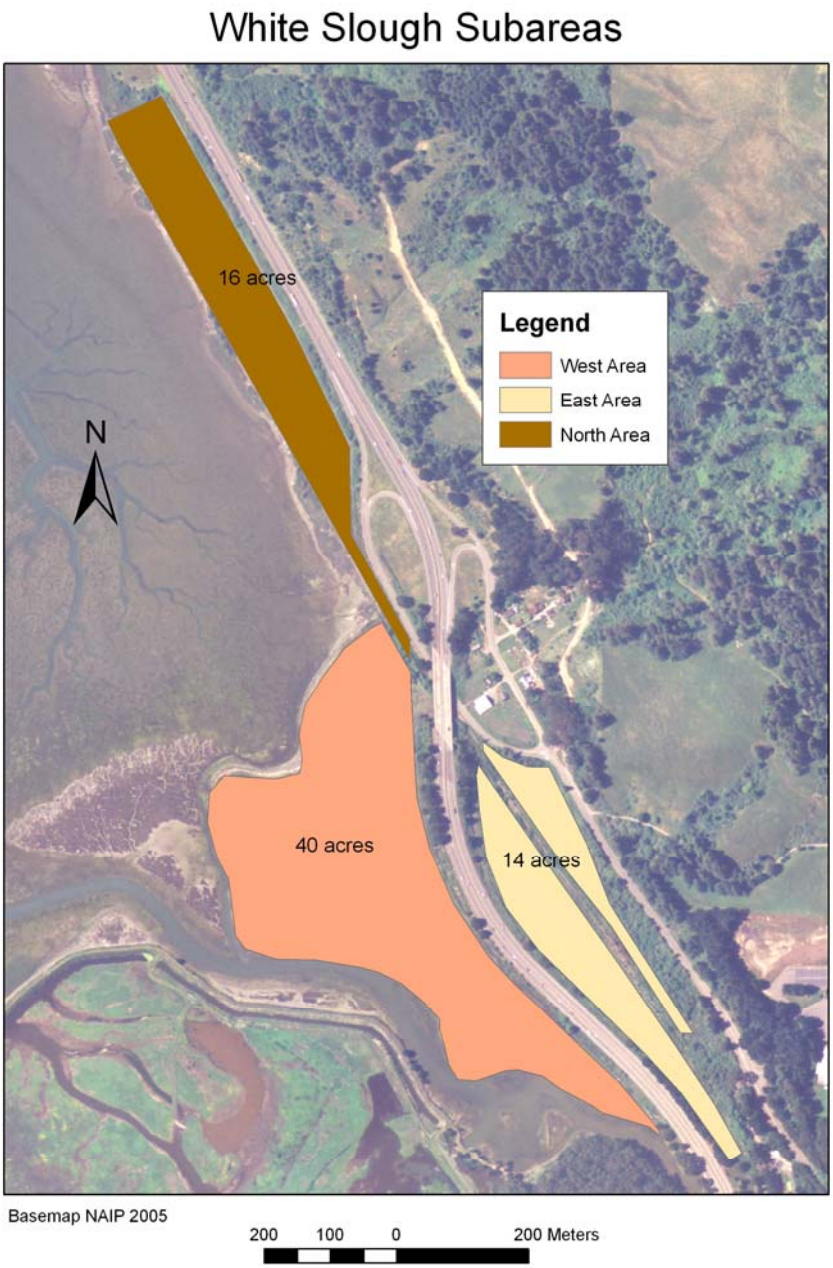

Fig. 2. Subareas of White Slough diked lands.

Table 3. Generalized vegetation types within diked subareas.

	Sub-area			
Vegetation Type	**North**	**West**	**East**	**Total**
Brackish Marsh	16	33.4	9.8	**59.6**
Freshwater Marsh			3.3	**3.3**
Riparian/swamp			0.9	**0.9**
Ag wetland		2.4		**2.4**
TOTAL	**16**	**35.8***	**14**	**65.8**

*Totals for West area exclude dikes, resulting in the discrepancy between the acreage of the subunit (40) and the vegetation (35.8)

The vegetation types listed in Table 4 are broad and represent physiognomic and functional types. Alliance-level mapping of the vegetation has only been carried out in the West Area (Fig.3, Table 4). Alliance level mapping allows the assessment of biodiversity, rarity of vegetation, and value to wildlife. Of the total of 35.8 acres of wetland in the West sub-area, 9.2 acres are covered with invasive or non-native vegetation (of which 2.4 acres have value as Aleutian cackling goose fodder). The remaining 26 acres of native vegetation is composed primarily of the *DISTICHLIS SPICATA* Alliance (Seashore salt grass Alliance). This alliance is very low in species diversity, consisting of the native salt grass, invasive sickle grass (*Parpaholis strigosa*) and occasional non-native creeping saltbush (*Atriplex triangularis*). As part of a functioning salt marsh, where it occurs as a more diverse association within the alliance, the Seashore saltgrass alliance would be of much higher value. Behind the dikes it forms a near monoculture of low wildlife value and biodiversity.

Table 4. Alliance types, acreages, and values in the West sub-area.

Alliance Name	Common Name	Acres	Value
AGROSTIS STOLONIFERA	Spreading bentgrass	4.4	Invasive, low wildlife value
COTULA CORONOPIFOLIA	Brass buttons	1.4	Non-native, low wildlife value
DISTICHLIS SPICATA	Seashore salt grass	22.3	Native, common, low wildlife value
HOLCUS LANATUS/LOLIUM MULTIFLORUM	Velvet grass/Italian ryegrass	2.4	Invasive, Aleutian cackling goose grazing habitat
JUNCUS LESUEURII	Salt rush	2.7	Native, common, low wildlife value
SALICORNIA VIRGINICA	Virginia glasswort	0.6	Native, declining in salt marshes
SPARTINA DENSIFLORA	Humboldt cordgrass	1.0	Invasive, low wildlife value
	Open water	1.0	

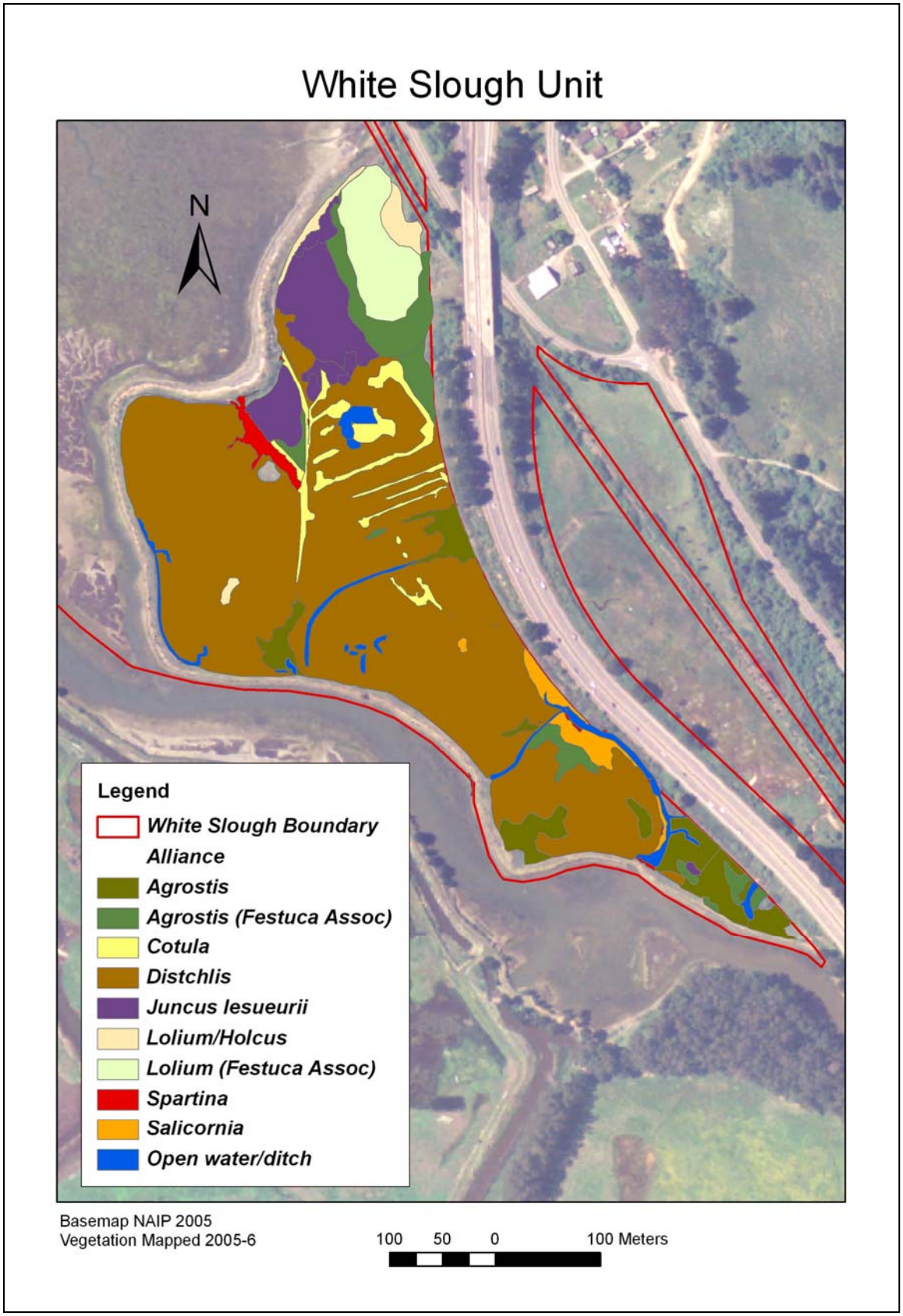

Fig. 3. Alliance level vegetation map of Western subarea.

Topographic contours are available from LIDAR for most, but not all of the West sub-area, and a contour map based on a datum of MLLW is under development. Based on past characterization of vegetation, the elevations on site are highest in the agricultural wetland areas to the northeast. The surface elevation is substantially subsided within the dikes, with a 3-foot discrepancy between the salt marsh just outside the dikes and the majority of the diked wetland. Since the salt marsh outside the dikes is comprised of almost pure stands of *Spartina densiflora*, an additional elevation gain would be needed to establish the high elevation mixed marsh type. Only data from North Bay have been analyzed to examine relationships between elevation and salt marsh type, and additional analysis will be needed to design an appropriate elevation for mixed marsh.

Recent NRCS mapping of soils on the West sub-area are not finalized, and the maps are highly generalized. Because the West sub-area was previously salt marsh, the soils are typically a silty clay loam below the O horizon. Based on past studies at the refuge, the soil characteristics are tied to alliance type. Underlying the Seashore salt grass Alliance, which is the dominant vegetation present (Fig. 4), soil salinity is mesohaline (brackish), soils are acidic, and are seasonally flooded. Beneath the Salt rush Alliance, soils are Oligohaline (moderately brackish), seasonally saturated to flooded, and acidic.

Figure 4: The *DISTICHLIS SPICATA* Alliance, composed of Distichlis and invasive sickle grass (Parapholis strigosa).

In contrast, the Velvet grass and Italian ryegrass Alliances are fresh to slightly brackish, seasonally saturated but to temporarily flooded, and of a higher pH. It should be noted that the freshwater spring originating to the east of the site was recently diverted to drain directly into the pasture areas of the West sub-area and may result in altered hydrology.

SITE JUSTIFICATION AND CONSTRAINTS

The White Slough Unit has previously been identified by HBNWR as an excellent site for an experimental/demonstration estuarine restoration project based on its small size, existing low habitat and biodiversity values, and nearby freshwater source. Based on vegetation mapping of the southern units of HBNWR, the vegetation types present are common, and some are dominated by non-native or invasive vegetation. There has been little recent use of the site for grazing or haying, and in its present condition it is of little value to migrating Aleutian cackling geese or other waterfowl. However, it has been designated by the U.S. Fish and Wildlife Service as proposed Critical Habitat for the endangered Tidewater goby. Any project undertaken on the site would need to fulfill habitat needs for that species.

Although all of the diked portions of the unit may be suitable for restoration of tidal influence, the presence of the railroad on the north and eastern portions make those areas of secondary interest. The current dikes are deteriorating, necessitating a management decision for the site. Emergency repairs of the most eroded portion of the dike (in the northern section of the western site) need to be undertaken immediately in order to preserve management options and allow for adequate design of a project (Fig. 5).

Figure 5. Eroded dike on the northwestern portion of the site.

In addition to the need to maintain Tidewater goby habitat, there are several other constraints on the site. The location of Highway 101 adjacent to the site will require engineering to prevent increased risk of flooding if tidal influence is restored. There is currently riparian/swamp vegetation present on the eastern margin of the sub-area which is not in FWS ownership, and may be subject to conversion to salt marsh as a result of the project. Although the site is not currently managed as pasture, it has that potential, and the issues of agricultural preservation as well as Aleutian cackling goose management will need to be addressed.

The site has undergone extensive subsidence, similar to other agricultural wetlands around the bay. If the project is designed to coincide with the planned Salmon Creek Phase II restoration project, fill material resulting from that project can be used to raise elevations at a much lower cost than acquiring fill commercially. Disposal of the excavated Salmon Creek material would otherwise pose financial and regulatory challenges. The project may also be an opportunity to examine the feasibility of using dredge spoils from routine bay channel maintenance to increase elevations.

There are extensive regulatory requirements to carry out such a project. To raise elevations on the site will require fill into an existing wetland. There have been projects of this type carried out elsewhere, and they will provide some guidance on regulatory precedent.

CONCEPT SKETCH

The project is envisioned as a demonstration project that emphasizes experimental opportunities and is designed to further the science of estuary restoration in Humboldt Bay. Input would be sought from regulatory and management agencies as well as other stakeholders, such that the project achieves the maximum experimental value of use to the resource community. Funding would be sought first for the project design, and this design would then be used to estimate costs for implementation. Prior to design work, research will be done to review past estuarine restoration projects between San Francisco and Puget Sound. A thorough review of the literature will be conducted, regional and local experts consulted, and field visits made to similar past and current projects.

At this early stage of conceptualization, we envision the re-establishment of tidal flow to the site through any of several mechanisms including breaching or removing of dikes or modification of tidegates. Restoration of full tidal influence is preferred, accompanied by the raising of elevations within the diked area in order to create at least some area of high elevation salt marsh. Tidal channels would be excavated both to create fish habitat, and because past research has shown that this increases the rate of salt marsh development. It is likely that we will be restricted in terms of the area of raised elevation due to the cost of obtaining and placing fill, so some part of the site may be designed to function as mud flat. By varying elevations, long term monitoring will allow us to determine the rate of sedimentation and the time needed to achieve salt marsh elevations (if in fact this does occur through natural sedimentation). *Spartina densiflora* will undoubtedly be a colonization pressure, and this project will utilize exiting methods of control and possibly new preventative measures to demonstrate the ability to create and maintain salt marsh vegetation dominated by native species. The higher elevation areas may be appropriate for creating off channel habitat for tidewater goby.

PROJECT TIMING

Because of the proposed Salmon Creek restoration project and the just initiated refuge Comprehensive Conservation Planning process, it is recommended that this project be initiated as soon as possible. It is anticipated that, if funding were obtained early in 2007, the project design could be completed by early 2008. Permitting is estimated to take 6 months. Once funding for implementation is obtained, the project could be carried out over a 2-year period to allow for revegetation after suitable conditions have been created. Baseline measurements could be collected during the design stage. Long term monitoring would continue for a period of at least 10 years, and would address project objectives including bio-physical processes, vegetation development, and wildlife use (inclusive of fish and invertebrates). The project will be adaptive in nature, with a fairly intensive monitoring element that will allow us to gauge success and modify techniques as needed. In this sense, the project will not end after two years, but may continue to be modified until all feasible objectives are achieved.

Native, high elevation salt marsh with rare Humboldt Bay owl's clover, having naturally resisted invasion of Humboldt Bay cordgrass.
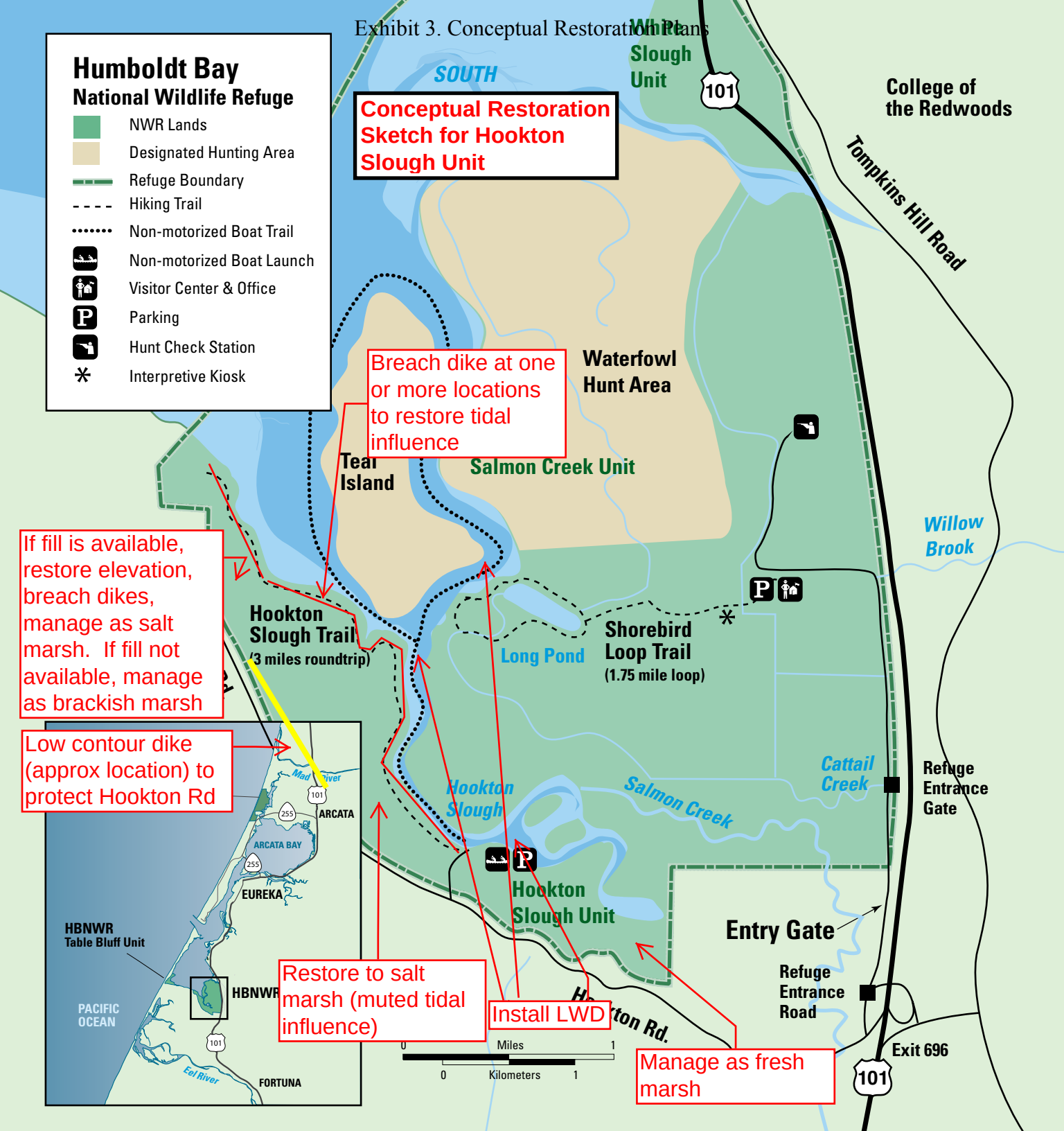
Exhibit 3. Conceptual Restoration Plans