

A Review of Caspian Tern Nesting Habitat

*A Feasibility Assessment of Management Opportunities
in the U.S. Fish and Wildlife Service Pacific Region*



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A Review of Caspian Tern (*Sterna caspia*) Nesting Habitat:
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ABBREVIATIONS AND ACRONYMS USED

a = acre

CDFG = California Department of Fish and Game

Corps = U.S. Army Corps of Engineers

DNR = Washington Department of Natural Resources

ft = feet

ha = hectare

km = kilometer

m = meter

mi = mile

NOAA Fisheries = National Marine Fisheries Service,
National Oceanic and Atmospheric Administration

NWR = National Wildlife Refuge

ODFW = Oregon Department of Fish and Wildlife

RM = river mile

USFWS = U.S. Fish and Wildlife Service

WDFW = Washington Department of Fish and Wildlife

INTRODUCTION

This report is one part of a comprehensive effort to seek solutions to the issue of Caspian tern predation on listed salmonid smolts in the Columbia River estuary. Through interagency coordination and a formal mediation process sanctioned by the Ninth Circuit Court of Appeals (April 2002), Federal and State agencies, and nongovernmental organizations agreed to explore options for restoring, creating, and enhancing nesting habitat for Caspian terns throughout portions of the Pacific Coast/Western region (Figure 1.a) as one means to reduce and disperse the large tern colony on East Sand Island in the Columbia River estuary. The benefits of this action would be to reduce the level of tern predation on out-migrating Columbia River smolts and also lower the vulnerability of a significant portion of the breeding Caspian terns in the Pacific Coast/Western region to catastrophic events such as disease, oil spills, or storm events.

The objective of this Feasibility Assessment is to evaluate a broad array of sites throughout Washington, Oregon, California, Idaho, and Nevada to determine management opportunities for the creation, enhancement or expansion of Caspian tern nesting sites based on biological features only. Sites were considered to have management potential for Caspian tern habitat if suitable habitat was present (or easily achievable through manipulation), relatively stable, and in close proximity to prey resources.

Site assessments focused on Federal and State owned lands. However, a few sites in private ownership (partial or total) were also included. We assessed a total of 77 sites (Table 1) dispersed throughout the study area (Figure 1.b). Biological features assessed at each site served as a “course filter” to identify a suite of potential management opportunities. Assessments of social, political, and economic issues associated with potential management sites are not discussed in this report but will be necessary before making decisions associated with long-term management of Caspian terns.

This Feasibility Assessment is not a decision document and serves only as a technical report on Caspian tern habitat management opportunities in the Pacific Coast/Western region. More detailed assessments, extensive public input, interagency coordination, and research will be required to determine if habitat management for Caspian tern conservation is necessary, and if so, the location and number of sites needed for management. The analysis, outreach, and coordination necessary for decision making will occur during the development of a Caspian Tern Management Plan for the Columbia River Estuary (Management Plan) and associated Environmental Impact Statement (EIS). This Management Plan and EIS are required elements stipulated in a 2002 U.S. Ninth Circuit Court mediated Settlement Agreement (2002 Settlement Agreement) pursuant to National Audubon Society, et al. v. Colonel Randall J. Butler et al., August 2001. The 2002 Settlement Agreement established a process and timeline for the development of the EIS and Management Plan. This includes a 2-year period (2003-2004), following the completion of this Feasibility Assessment, to further assess the potential of establishing or re-establishing tern colonies in the Pacific Coast/Western region. Studies conducted during this two year period may include the evaluation of fisheries resources or tern diet composition and further research into tern management techniques. To initiate the EIS process, the U.S. Fish and Wildlife Service, in cooperation with the Corps and NOAA Fisheries, will begin formal scoping in the spring of 2003 as part of the EIS public input process. Other

outreach efforts include contacting landowners, local county governments, local tribal governments, and special interest groups.

The development of management alternatives will be an integral component of the EIS and Management Plan. The analysis of alternatives will address the full array of biological, social, political and economic issues for all alternatives considered. Decisions on the need to develop additional tern nesting habitat and long-term relocation of terns will not be finalized or implemented until further research, necessary planning, coordination, and public input has been completed through the EIS process. Completion of the EIS is scheduled for March 2005. This report, and two additional technical reports completed in compliance with the 2002 Settlement Agreement, entitled the “Status Assessment and Conservation Recommendations for the Caspian Tern in North America” (Shuford and Craig 2002) and “Caspian Tern Predation on Salmon and Steelhead Smolts in the Columbia River Estuary” (NOAA Fisheries 2002) will provide managers and decision makers a foundation for science-based planning, management, and issue resolution.

This report is organized by nine geographic regions (Figure 1.b). Each region is defined at the beginning of their respective section in the report including a map with the identification of evaluation sites. Regional discussions include a general overview of sites in the region, summarizing habitat and management issues; a detailed description of sites with tern management potential, including requirements necessary for successful habitat management and attraction of Caspian terns; and a brief description of sites with no management potential. Detailed field forms for each site assessed are compiled in a supplementary appendix to this report (Appendix A) available on the web (<http://migratorybirds.pacific.fws.gov/reports.htm>).

METHODS

We focused site assessments on historic and currently active Caspian tern colonies in Washington, Oregon, Idaho, Nevada, and California. A colony is considered active if tern nesting (at least 2 pairs) was documented within the last 5 years (1998-2002). A colony is considered historic if there has been at least 1 year of documented nesting activity but nesting has not been confirmed in the last 5 years. We also assessed areas with potential nesting habitat based on recommendations from local biologists and a review of existing aerial photos or maps for all states. Since there are no current or historic Caspian tern nesting sites in the coastal Oregon region, we conducted one aerial survey (July 2002) to assist in the identification of potential tern nesting habitat. In all, 77 sites were assessed to determine their potential as alternate nesting habitat for some of the terns currently nesting on East Sand Island in the Columbia River estuary. We contacted managers, researchers, and biologists to arrange site visits and solicit information on each of the 77 sites (Table 1). We attempted to visit all sites, but because of time constraints, field schedules, and logistics this was not possible for a few sites. Instead, we conducted interviews with local biologists or site managers to gather information on these sites. In addition, several sites that were historically used by small numbers (<50) of Caspian terns, primarily in California, were not included in the study if the site offered little potential of supporting nesting Caspian terns and more appropriate sites were nearby. For example, several sites that have supported Caspian terns in the past are scattered throughout San

Francisco Bay. The sites in San Francisco Bay included in this study were considered to have the best management potential based on the recommendations of local biologists and managers.

For each site, we collected biological information to assess the current status and determine the sites' potential to serve as an alternative habitat for some of the birds constituting the East Sand Island colony. Information collected included description of habitat, fish and wildlife resources, current and historic site management, and management potential. The best available information was used for some sites which did not have extensive documentation on fish and wildlife resources. We obtained aerial photo images if available and took photographs of most sites. Site information was recorded on field forms, which were compiled with site photographs in Appendix A (<http://migratorybirds.pacific.fws.gov/reports.htm>).

Based on the initial assessment of each sites' biological features, we identified sites with potential opportunities for Caspian tern habitat management. Determination of sites with management potential involved several criteria: (1) suitability of existing habitat or the amount and type of habitat enhancement required to make it suitable for Caspian terns, (2) site stability or long-term habitat availability, (3) the ability of the site to support a substantial Caspian tern colony, (4) abundance and type of available prey resources, (5) presence of potential predators (mammalian and avian), and (6) expected levels of natural or human disturbance. These potential sites were then further evaluated in relation to regional management goals and local management needs. Further evaluation included actual management needs (e.g., restoration, enhancement, or predator control) and stakeholders that would need to be involved.

Sites with management potential were then assessed using a two tiered ranking process to identify sites with the best management opportunities. Tier I criteria were developed to rank the potential of each site to contribute to the primary goal of reducing salmonid predation in the Columbia River estuary and aimed to sort sites into high (Tier I sum ≥ 18), medium (Tier I sum = 15-17), or low (Tier I sum ≤ 14) categories of management potential. Tier I criteria evaluated sites from a regional (Pacific Coast/Western) perspective in relation to the objective of redistributing the tern colony on East Sand Island to lessen smolt predation in the estuary and the vulnerability of the regional Caspian Tern population to catastrophic events. Tier II criteria assessed selected local conditions using site specific factors most likely to effect long-term management needs. Two of the Tier II criteria, human disturbance and predation, are also factors known to effect efforts to establish or re-establish tern colonies at historic or abandoned sites, respectively.

Site assessment criteria and rankings are defined as follows:

TIER I CRITERIA

I.a. Site Status: This criterion ranks the potential of a site to support a Caspian tern nesting colony, and in particular the potential to attract terns from East Sand Island. Recognizing the significance past use and the social aspects of colony establishment, a current or historic site was determined to have better potential to serve as an alternate nesting site compared to a site with no prior nesting activity.

5 = active (birds have nested within the last 5 years)

3 = documented prior use but nesting has not been confirmed in the last 5 years

0 = no documentation of any Caspian tern nesting

I.b. Conflict with salmonids: This criterion ranks sites according to their potential for conflicts with salmon conservation and management. Wildlife managers want to avoid shifting avian predation from listed Columbia River salmon to areas with concentrations of other listed salmon stocks. Sites in areas with listed salmon stocks are thus less desirable as tern management sites than sites where listed salmon do not occur.

5 = listed salmon not available as potential prey item

3 = listed salmon are present as potential prey but there is a good abundance of non-salmonid prey items (e.g., marine fish)

0 = listed salmon are likely to be the primary prey base for Caspian terns

I.c. Proximity to East Sand Island: This criterion ranks the likelihood of terns from the East Sand Island colony relocating to a particular alternate nesting site. Although Caspian tern migration routes are not entirely understood, the distance a site is located from East Sand Island serves as a practical measure of the sites' encounter probability. The closer a site is to the Columbia River estuary, the greater the probability that a tern from the East Sand Island colony will encounter the site. Because of the uncertainty of the terns specific migration routes, this criterion is weighted less heavily than the other Tier 1 criteria.

3 = site < 200 km from East Sand Island

2 = site 200-500 km from East Sand Island

1 = site > 500 km from East Sand Island

I.d. Site Capacity: This criterion assesses the potential site capacity (number of nesting Caspian terns) of each site. A site with a higher capacity offers greater potential to support a substantial number of terns from East Sand Island compared to sites with a limited site capacity.

- 5 = potentially > 2000 nesting pairs
- 3 = potentially 350 to 1000 pairs
- 1 = potentially < 350 pairs

I.e. Conflicts with other listed species or species of concern (non-salmonids): This criterion assesses the potential for conflict with non-salmonid listed species or species of concern. Similar to Criterion 1.b., which assesses potential conflicts with listed salmonids, managers want to avoid focusing tern habitat enhancement or relocation activities to sites where conflicts with other listed species might occur. One example of a potential conflict considered by this factor would be competition for nesting space between Caspian terns and the listed California least tern on sites with limited nesting habitat. If there is no or low likelihood of conflict with a listed species, the site has better potential for Caspian tern management.

- 5 = no other listed species occur at the site
- 3 = listed species are present but there is a low likelihood of conflict
- 1 = listed species are present and there is relatively high potential for conflict, such as competition for nesting habitat

I.f. Site Availability: This criterion assesses site suitability in the context of time. Some sites are currently suitable and immediately offer alternate nesting habitat for terns from the East Sand Island colony. Other sites may require extensive habitat enhancement or development requiring a lengthy process of consultation, permitting, and coordination. This criterion is very important as the goal stipulated in the 2002 Settlement Agreement is to implement management actions to reduce tern predation on Columbia River smolts by 2005.

- 5 = site is currently suitable for nesting or requires only minor enhancement or modification
- 3 = site is available after extensive manipulation, such as dredging, island expansion, or vegetation removal with heavy equipment
- 1 = site needs to be constructed, requiring extensive permitting, consultation, and labor

TIER II CRITERIA:

II.a. Habitat maintenance: This criterion ranks the degree of habitat maintenance required for long-term site management for Caspian terns. A site that will not require intensive, long-term management was ranked more favorably than those requiring intensive, annual maintenance to ensure suitable habitat is available for terns on an annual basis.

- 3 = short-term or infrequent management requirements
- 2 = annual habitat maintenance but no heavy equipment required
- 1 = annual maintenance and heavy equipment required

II.b. Human disturbance: This criteria ranks the level of human disturbance that might occur at a site. A site with no human disturbance, or those with manageable human disturbance, will have better potential as a long-term Caspian tern colony site compared to those sites easily accessible and unprotected from human access.

- 5 = site is relatively inaccessible with no established human use
- 3 = site is accessible with a history of human use; disturbance levels are manageable
- 1 = site is readily accessible with regular human use and there are limited opportunities for managing use.

II.c. Predators: This criterion ranks the expected level of predation that might impact a Caspian tern colony. This is an important factor to consider if it is determined that new colony sites are to be established. Most efforts to re-establish abandoned colonies and projects to facilitate colonies at new sites require predator control during the initial years of colony establishment (Kress and Hall 2002). In some cases, control of gull and mammalian predators will be an ongoing management need. Sites with relatively low levels of predation offer the greatest potential to serve as successful, long-term colony sites for Caspian terns.

- 5 = inaccessible to mammals and no known concentration of avian predators in close proximity
- 3 = avian and/or mammalian predators on-site or nearby, but potential impacts to tern colony are low or manageable
- 1 = site accessible to mammals and high concentration of avian predators on-site or nearby

Tier II criteria ranks were summed then multiplied by a category factor, resulting in a Total Site Score. The category factor is based on whether a site was categorized as high (factor of 5), medium (factor of 3), or low (factor of 1) after the Tier I ranking. A site with a higher Total Site Score has greater potential for tern management compared to those with lower ranking totals.

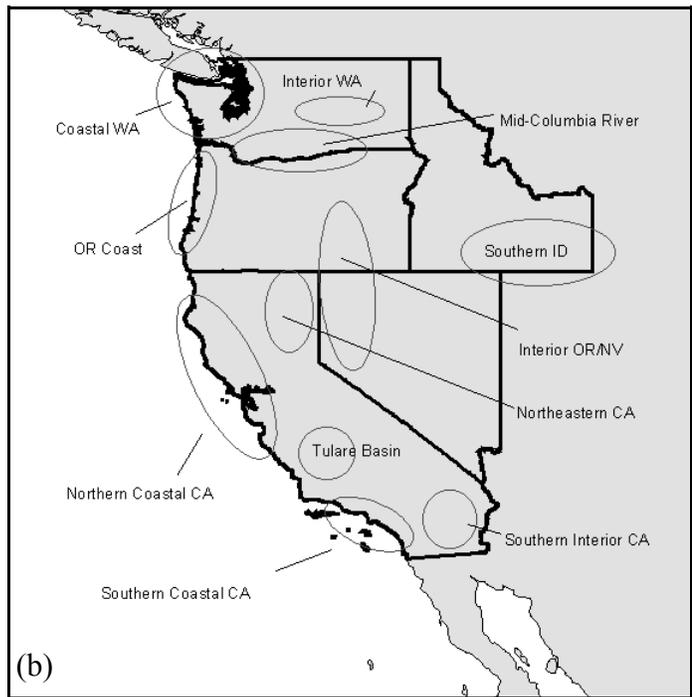


Figure 1.a. Outlines of breeding regions of the Caspian tern in North America, including the Pacific Coast/Western region (from Wires and Cuthbert 2000) and 1.b. Feasibility study area and outlines of regional evaluation areas.

TABLE 1. Nesting status of the Caspian tern at 77 sites assessed in the Pacific Coast/Western region.

Site Name	Nesting Status		
	Current	Historic	Absent
COASTAL WASHINGTON			
Sand Island, Grays Harbor		x	
No Name Island, Grays Harbor			x
Unnamed Island, Grays Harbor			x
Cate Island, Grays Harbor			x
Bldg 407, Commencement Bay	x		
McNeil Island, Puget Sound			x
Snag Islands, Willapa Bay			x
Unnamed Island, Padilla Bay	x ^a		
Jetty Island, Puget Sound		x	
INTERIOR WASHINGTON			
Solstice Island, Potholes Reservoir	x		
Unnamed Island, Potholes Reservoir	x		
Harper Island, Sprague Lake	x ^b		
Unnamed Island #1, Banks Reservoir	x ^b		
Unnamed Island #2, Banks Reservoir	x ^b		
Goose Island, Banks Reservoir	x ^b		
MID-COLUMBIA RIVER			
Crescent Island	x		
Straight Six Island, Umatilla			x
No Name Island #1, Umatilla			x
No Name Island #2, Umatilla			x
No Name Island #3, Umatilla			x
“Test” Island, Umatilla			x
Miller Rocks		x	
Threemile Canyon Island		x	
COASTAL OREGON			
Unnamed Island, Coos Bay			x
“South” Island, Coos Bay			x
“Middle” Island, Coos Bay			x
“North” Island, Coos Bay			x
Unnamed Island, Umpqua River Estuary			x

TABLE 1. (cont.) Nesting status of the Caspian tern at 77 sites assessed in the Pacific Coast/Western region.

Site Name	Nesting Status		
	Current	Historic	Absent
Steamboat Island, Umpqua River Estuary			x
Fern Ridge Reservoir, Oregon			x
INTERIOR OREGON/NEVADA			
Pelican/Crump Lake, Oregon	x ^a		
Summer Lake, Oregon	x ^a		
Tern Island, Malheur Lake, Oregon		x	
Anaho Island, Pyramid Lake, Nevada		x	
Stillwater NWR, Nevada		x	
Carson Sink, Nevada		x	
SOUTHERN IDAHO			
Unnamed Island, Mormon Reservoir	x		
Tern Island, Minidoka NWR		x	
Gull Island, American Falls Reservoir	x		
Gull Island, Blackfoot Reservoir	x		
Unnamed Island, Bear Lake NWR		x	
NORTHERN COASTAL CALIFORNIA			
Sand Island, Humboldt Bay	x		
Knight Island, San Pablo Bay	x		
Brooks Island, San Francisco Bay	x		
Runway wetland, Alameda NWR			x
West wetland, Alameda NWR		x	
Pond A7, South San Francisco Bay	x		
Pond A16, South San Francisco Bay			x
Baumberg Tract, South San Francisco Bay	x		
Elkhorn Slough, Monterey Bay	x		
Salinas River, Monterey Bay	x		
SOUTHERN COASTAL CALIFORNIA			
Terminal Island, Los Angeles Harbor	x		
Upper Newport Bay Ecological Reserve, Newport Beach			x
Bolsa Chica Ecological Reserve, Huntington Beach	x		
San Diego Bay NWR (Saltworks)	x		

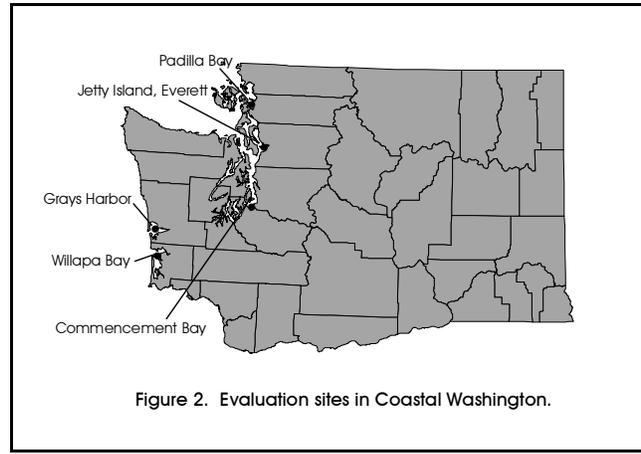
TABLE 1. (cont.) Nesting status of the Caspian tern at 77 sites assessed in the Pacific Coast/Western region.

Site Name	Nesting Status		
	Current	Historic	Absent
NORTHEASTERN CALIFORNIA			
Meiss Lake, Butte Valley, Wildlife Area		x	
Lower Klamath NWR		x	
Tule Lake NWR		x	
Clear Lake NWR		x	
Goose Lake		x	
Bird Island, Big Sage Reservoir		x	
Honey Lake Wildlife Area		x	
Mono Lake		x	
TULARE BASIN			
Lemoore Naval Air Station		x	
Westlake Farms North Evaporation Basin		x	
Tulare Lakebed			
Westlake Mitigation Wetland, section 3		x	
Westlake Farms South Evaporation Basin		x	
South Wilbur Flood Area		x	
Hacienda Ranch Flood Basin		x	
Tulare Lake Drainage District, South Evaporation Basin		x	
SOUTHERN INTERIOR CALIFORNIA			
Obsidian Butte, Salton Sea		x	
Morton Bay, Salton Sea		x	
Headquarters Unit "D," Salton Sea NWR		x	
Mullet Island, Salton Sea		x	
Unit 1-B4, Salton Sea NWR		x	
Unit 1-A4, Salton Sea NWR			x
^a No survey conducted			
^b Suspected nesting but not confirmed			

REGIONAL DISCUSSIONS

COASTAL WASHINGTON

For the purposes of this report, the Coastal Washington region includes the outer coastal areas of the state and Puget Sound. There are 34 principal bays and estuaries in Washington (O’Mealy and Johnson 2001). Key estuarine habitat include the lower reaches of rivers, intertidal sand and mud flats, saltwater and brackish marshes, and open water. Organics, silt, and sand are the primary substrate components of this habitat, varying in specific composition and distribution (O’Mealy and Johnson 2001)



Caspian terns have nested in coastal Washington at Grays Harbor, Willapa Bay, and at the Everett Naval Station, Padilla and Commencement bays in Puget Sound (Figure 2, Shuford and Craig 2002, R. Milner, WDFW, pers. comm.). Grays Harbor and Willapa Bay have extensive tidal flats with sandy islands developing in some locations. Caspian terns formerly nested on exposed sand islands in these two areas. Islands in Willapa Bay are especially dynamic, changing shape and size seasonally. The islands at Grays Harbor are slightly more stable and some are heavily vegetated with European dune grass (*Ammophila arenaria*). The small tern colony in Padilla Bay occupied habitat similar to that in Grays Harbor, but the islands are human-created and not as dynamic or large. Terns in Commencement Bay have recently nested in a variety of non-typical habitats, including a covered contaminated soil site (ASARCO), barges, and a building rooftop. The Commencement Bay colonies are believed to have been formed from terns that formerly nested on cleared, bare ground at the Everett Naval Station. These terns were hazed from that site in 1995.

Primary prey species that occur in the Coastal Washington region include a variety of marine fishes and salmonids. See detailed descriptions in each section for primary prey species for specific bays or estuaries. Table 2 lists salmonids that occur in the areas colonized by Caspian terns in the Washington Coast region. The main management issues at Coastal Washington sites are the lack of stable nesting habitat, vegetation encroachment, potential conflicts with salmon smolts, and predators. WDFW has expressed concerns regarding the potential impacts to salmonids that may result from any Caspian tern relocation efforts to historical or new coastal nesting sites in Washington. On-site diet studies would assist in determining potential impacts. However, any colony re-established in Coastal Washington would be managed to be significantly smaller than the East Sand Island colony and therefore, potential affects to salmonids would likely be substantially less than in the Columbia River estuary.

TABLE 2. Evolutionarily Significant Units of Salmonids in Willapa Bay, Grays Harbor and Puget Sound.

Species	Evolutionarily Significant Unit	Listing Status
Chinook Salmon	Washington Coast	Not Warranted
	Puget Sound	Threatened
Steelhead	Southwest Washington	Not Warranted
	Puget Sound	Not Warranted
Chum Salmon	Pacific Coast	Not Warranted
	Puget Sound/Strait of Georgia	Not Warranted
	Hood Canal Summer run	Threatened
Coho Salmon	Puget Sound/Strait of Georgia	Candidate
	Lower Columbia River/Southwest Washington	Candidate
	Olympia Peninsula	Not Warranted
Coastal Cutthroat Trout	Southwestern Washington	Not Warranted
	Puget Sound	Not Warranted
Pink Salmon	Even-year	Not Warranted
	Odd-year	Not Warranted

Coastal Washington Sites With Management Potential

Grays Harbor

Five islands (Figure 3) were evaluated in Grays Harbor. These will be discussed together in this section because their physical characteristics, prey bases, and management issues are very similar. All of the islands are owned by DNR, except for Cate Island, which is owned by DNR and a private landowner.

Caspian terns first nested in Grays Harbor in 1957 and moved between three islands (Sand, Goose, and Whitcomb islands; the two latter islands are now submerged at all tidal levels; Shuford and Craig 2002).

Numbers reached a peak of 3,590 pairs on Sand Island in 1987; birds last nested in Grays Harbor in 1989. A combination of gull predation and bald eagle disturbance are believed to be the cause of colony abandonment (Shuford and Craig 2002).

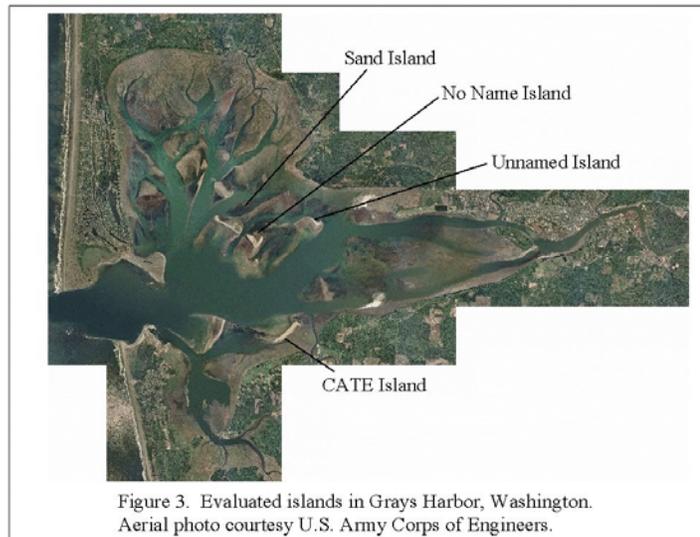


Figure 3. Evaluated islands in Grays Harbor, Washington. Aerial photo courtesy U.S. Army Corps of Engineers.

Site Descriptions

Sand Island: Located in the north bay, Sand Island is one of three historic nesting islands in Grays Harbor. Sand Island is flat and mostly vegetated with dense European dune grass. Large willow (*Salix* spp.) shrubs grow at higher elevations. A long sandy spit, which extends northwest, is the historic tern nesting area. A colony of western (*Larus occidentalis*) x glaucous-winged gulls (*L. glaucescens*) currently nest on the island. The island appears to be semi-stable with only the sandy spit changing shape and size annually.



Aerial view of Sand Island.



Sandy shoreline and vegetated area on No Name Island

No Name Island: No Name Island, located just east of Sand Island, is smaller and flat but has been increasing in size (J. Smith, WDFW, pers. comm.). The majority of the island is vegetated with European dune grass, most of which was established in the last two years (J. Smith pers. comm.); the northwest end remains unvegetated. Caspian terns have not been observed to nest on this island, but it supports a western x glaucous-winged gull colony of about 500 pairs.

Unnamed Island: This relatively small island first appeared in the late 1990s (J. Smith pers. comm.), but it appears to be increasing in size. Scattered forbs are the only vegetation on the island. The low shifting sand dunes cover most of the island. No colonial waterbirds nest on this island, but adult Caspian terns have been observed roosting on a sandy spit on the north end.



Shifting sand dunes on Unnamed Island.

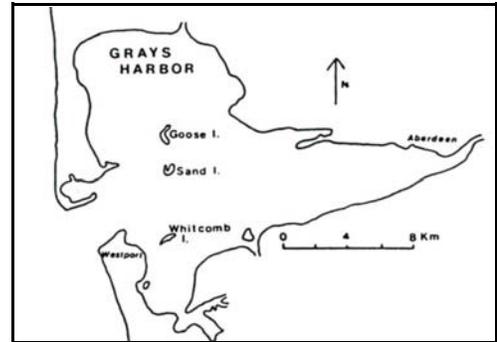


Sandy spit on CATE Island

Cate Island: This island is located along the southern portion of the harbor near the mouth of John's River. The island is flat and heavily vegetated with dune grass, scotch broom, and willow. Large numbers of post-breeding adults and fledglings have been observed roosting on a sandy spit on the southeastern end. A portion of this island is privately owned and used frequently as a recreational destination by the owner.

Whitcomb

Island: This island is now submerged under high tides and is located 2 km east of Westport (Penland 1982). In the past, Whitcomb was a 5 ha low-lying island with sparse vegetation and scattered driftwood. The first estimate of breeding pairs (1075) was made in 1975. The colony reached a peak of 1240 in 1976, then dropped to 10 pairs in 1979. Gull encroachment and island erosion caused this colony to abandon by the 1980s. This site is under consideration for use as a mitigation project by the Corps and thus, may be re-constructed, making habitat available for terns.



Map depicting historic location of Whitcomb Island (from Penland 1982).

Prey Base

A variety of marine fishes can be found in Grays Harbor. These include: northern anchovy (*Engraulis mordax mordax*), Pacific herring (*Clupea harengus pallasi*), shiner perch (*Cymatogaster aggregata*), chum salmon (*Oncorhynchus keta*), coho salmon (*O. kisutch*), surf smelt (*Hypomesus pretiosus pretiosus*), and Pacific staghorn scuplin (*Leptocottus armatus*, Penland 1976). Penland (1976, 1981) reported a variety of prey species in the Caspian tern diet. In 1975, 30 fish specimens collected at Whitcomb Island consisted primarily of shiner perch (47%), chum salmon (21%), and Pacific staghorn scuplin (17%). In 1976, a total of 59 specimens were collected, which included Northern anchovy (44%), shiner perch (20%), surf smelt (14%), coho salmon (14%), and Pacific herring (5%).

Management Issues

The primary management issue for all islands in Grays Harbor is the need to provide stable and unvegetated nesting habitat. Areas on the islands that are stable quickly become vegetated. Vegetation could be removed from areas on the islands immediately adjacent to open sandy locations to provide larger and more stable tern nesting habitat. However, vegetation encroachment will most likely be a continual process, thus, long-term management of a Caspian tern colony on any of these islands would require repeated vegetation removal, possibly on an annual basis.

It is possible that the presence of a gull colony on Sand and No Name islands may attract nesting Caspian terns given tern colonies are often found adjacent to gull colonies. However, gull predation on tern eggs and chicks would most likely occur. In addition, bald eagles are also present in the harbor. Persistent bald eagle activity has caused significant egg and chick losses when gulls capitalize on eagle-induced panic flights (Shuford and Craig 2002). Gull predation may be an issue principally while a tern colony is being established. Thereafter, a tern colony would likely be able to prosper despite mortality from gull predation similar to that at other colonies in the Pacific Coast/Western region. However, since it appears that the historic Caspian tern colony abandoned Grays Harbor because of gull predation and eagle activity, long-term monitoring and predator control may be needed to ensure a successful Caspian tern colony.

Mammalian predation and potential human disturbance are issues on Cate Island. This island is separated by a shallow channel from the shoreline (<1 mi), making it possible for mammalian

predators, such as coyotes, to reach the island at low tides. Human activities, such as camping and picnicking, on the privately owned portions of the island can also disturb nesting Caspian terns if people or pets (e.g., dogs) enter the colony site.

Another management issue is the potential conflict of tern predation on salmon smolts. Five species of salmon migrate through Grays Harbor, none of which are currently listed under the Endangered Species Act. However, one of the five species, coho salmon, is currently a candidate species for Federal listing. Diet information from the historic colony indicates that terns feed on a variety of marine fishes in addition to salmonids. Timing of smolt migration and abundance of marine prey will influence salmon consumption by a Caspian tern colony.

Opportunities and Needs

Goose and Sand islands were designated “Natural Area Preserves” by DNR in 1973, to protect nesting Caspian terns and harbor seals, respectively. As Goose Island is no longer available for Caspian terns, one or more of the remaining islands discussed above can replace this lost habitat that was protected specifically for Caspian terns. Many post-breeding adults and fledglings are observed in Grays Harbor each year. Thus, there is great potential for re-establishing a tern colony on one of these islands. Habitat management activities may require heavy equipment, but getting equipment out to the islands would be a logistical challenge because the islands are surrounded by shallow water. Vegetation removal may need to be done with hand tools, or the application of chemicals, and would most likely be necessary for the long-term. Gull control may be needed if predation levels prohibit successful colony establishment. On-site research on the diet composition of relocated Caspian terns would assist in evaluating the effects on salmonid species in the harbor. Alternatively, a study reviewing the timing of salmon smolt outmigrations and the availability of marine fish in the harbor would be useful in assessing potential conflicts with salmonids.

Management actions specific to Cate Island include (1) establishing a fence or signs to keep dogs or people out of a nesting tern colony and (2) coordinating with the private landowners to minimize disturbance to nesting Caspian terns. Consultation with the Corps will be necessary to determine if Whitcomb Island will be re-created and if so, during what time frame. Development of management plans and associated environmental review documents of any proposed project would involve landowners, local governments, and key agencies such as DNR, WDFW, USFWS, and the Corps.

Unnamed Island, Padilla Bay

Site Description

Padilla Bay, in northern Puget Sound near Anacortes, contains 4 dredge spoil islands along the Swinomish channel, a small navigation channel connecting Padilla and Skagit bays. Caspian terns started nesting on the northern-most island (privately owned) sometime in the early 1990s, reaching a peak of 126 nests in 1995 (M. Davison, WDFW, pers. comm.). Since this colony has

not been monitored in recent years, it is unclear whether terns are still nesting on this island, though adults have been observed in the area. This island is flat and vegetated with dense European dune grass. A sandy shoreline surrounds the island and extends out to mudflats. The island appears to be semi-stable with only the sandy shoreline changing shape and size. The terns nested on a small stretch of shoreline (300 sq m [3,049 sq ft]) on the northwest side of the island. A small (<250 pairs) colony of western x glaucous-winged gulls nests on the island.



Sandy shoreline and historic tern nesting area

Prey Base

A variety of marine fish are found in the bay including shiner perch, Pacific staghorn sculpin, northern anchovy, surf smelt, Pacific herring, and Pacific sand lance (*Ammodytes hexapterus*, Riggs 1997). Several salmonid species (chinook, coho, chum, pink, and sockeye) occur in the bay and are potential prey items.

Management Issues

The primary management issue in Padilla Bay is providing stable, unvegetated nesting habitat. The current nesting island is owned by a private individual who has considered selling the property for development in the past (T. Stevens, Padilla Bay National Estuarine Research Reserve, pers. comm.). The long-term availability of this island for nesting Caspian terns is unknown. In addition, the tern nesting area has recently eroded, making the area half the size it was several years ago (M. Davison, WDFW, pers. comm.). Vegetation can be removed inland and immediately adjacent to this area to provide a larger and more stable nesting area. However, erosion may continue to occur and thus some armoring of the shoreline may be necessary. The enhanced area would most likely require repeated vegetation removal and would remain relatively small, supporting a small (<300 pairs) nesting tern colony. However, it is possible that newly created islands currently under consideration (see discussion below) would provide a larger nesting area for terns, capable of supporting a larger Caspian tern colony.

Another management issue is the potential conflict from tern predation on migrating salmon smolts. Five species of salmon occur in Puget Sound (Table 2). Of these, chinook salmon is listed as threatened and the coho salmon is currently a candidate for listing. No information exists on diet composition of terns in this area. If marine fish are not as abundant as in estuaries on the outer coast, salmon smolts may serve as the predominant food source for nesting Caspian terns. However, potential impacts would most likely be small if a relocated tern colony remained small because of the limited habitat. Impacts may potentially increase if a larger nesting area of habitat was provided, allowing a larger Caspian tern colony.

Gull predation may be an issue, especially with a small tern colony. Because the island is close to shore and the navigation channel, there is a potential for human disturbance from boats and for predation by mammals from the mainland. However, there is no evidence that this is occurring.

Opportunities and Needs

As terns have nested on this island in the past, there is great potential for enhancing the current site to make it attractive to nesting terns. Habitat enhancement activities may require heavy equipment, but getting equipment to the islands would be a logistical challenge because the island is surrounded by shallow water. Vegetation removal may need to be done with hand tools or the application of chemicals. Because this island is currently privately owned, any management would require the cooperation of the landowner. The Padilla Bay National Estuarine Research Reserve owns and protects portions of the bay. The Reserve is continually seeking to acquire more land for long-term protection and thus could be a potential partner in the management of this site.

WDFW is currently considering the creation of islands in the bay to increase loafing areas for wintering gray-bellied brant (*Branta bernicla*, M. Davison, WDFW, pers. comm.). If this occurs, these islands could be used by nesting Caspian terns in the spring and summer when brant are gone. Discussions with WDFW would be necessary to ensure that the planning process for the creation of these islands would include providing Caspian tern nesting habitat. Gull control may be needed if predation levels prohibit successful establishment of a tern colony. On-site research on diet composition or a study on salmonid outmigrations would assist in evaluating effects on salmonid species in the bay. Development of management plans and associated environmental review documents of any proposed project would involve the landowner and key agencies such as WDFW, USFWS, and the Corps. Any proposed project at this site would require Endangered Species Act compliance.

Jetty Island, Everett

Site Description

Jetty Island, an artificial dredge spoil island, parallels the Everett waterfront in northern Puget Sound. The island is approximately 2.5 mi long and is mostly vegetated with dense Scotch broom (*Cytisus scoparius*). It is owned by the Port of Everett but managed by Everett City Parks. The island is open to public access year round and in the summer, the Parks operates a ferry boat to the island that is landing at the southern end. One to two pairs of Arctic terns formerly nested on an unvegetated sandy area at the southern tip of the island. This is the same location where < 20 Caspian terns attempted to lay eggs after they were displaced from the Everett Navy Base; all eggs were washed out at high tide. The Everett Navy Base colony was located within 1 mi from the southern tip of Jetty island and had as many as 2,600 nesting adults in 1994 (R. Milner, WDFW, pers. comm.). Caspian terns have not nested successfully on this island, and Caspian terns are no longer nesting at the Everett Navy Base.



Landing dock on southern end of Jetty Island

Prey Base

A variety of salmonids are found in this estuary, including wild and hatchery-reared coho salmon and hatchery-reared chinook and steelhead. The Swinomish River, which enters Puget Sound north of Jetty Island, contains the largest wild run of coho on the west coast (C. Kramer, WDFW, pers. comm.). This is a healthy run, with approximately 15% smolt-to-adult survival (C. Kramer pers. comm.). Other potential prey species include a variety of marine fish such as shiner perch, herring, and sandlance.

Management Issues

The primary management issue is providing stable, unvegetated nesting habitat. Jetty Island is heavily vegetated with the invasive Scotch broom. Nesting habitat for Caspian terns can be created by clearing an area at the northern tip of the island. This area would be far from the landing dock and primary public use area, reducing potential human disturbance. However, there are concerns that continual erosion of the western portion of the island may be a problem, especially if vegetation is removed (R. Milner pers. comm.). Armoring the shoreline may be necessary.

Another management issue is the potential conflict from tern predation on migrating salmon smolts. Five species of salmon occur in Puget Sound (Table 2). No information exists on diet composition of terns in this area. As with Padilla Bay, if marine fish are not as abundant as in estuaries on the outer coast, salmon smolts may serve as the predominant food source for nesting Caspian terns. However, the salmon runs in this estuary appear to be healthy and abundant, reducing the possibility that impacts of a Caspian tern colony would be significant.

Opportunities and Needs

Since this estuary supported nesting terns in the past, it appears possible to successfully relocate birds to this area. Coordination with the Port and Everett City Parks would be necessary before management plans are developed. Initial vegetation removal would require heavy equipment but annual maintenance would most likely be possible with hand tools or chemicals. Studies need to be conducted to determine if removal of vegetation may result in erosion of the island. Signs and a low fence can be installed to prevent the public and pet dogs from entering the enhanced area. On-site research on diet composition, salmon outmigrations, and the availability of marine fishes would assist in evaluating effects to salmonid species in the estuary.

Coastal Washington Sites Without Management Potential

Willapa Bay: Islands in Willapa Bay supported as many as 1,500 pairs of Caspian terns in the 1980s. This colony was inactive by 1990 because the main nesting island (Gunpowder Shoals) became inundated at high tides. Some islands (Snag Islands, Ellen Sands) still exist in the middle of the Bay. These islands are very dynamic, with dramatic seasonal changes in shape and size. It appears that only a small area remains above the highest tides in spring and summer, as evidenced by the lack of any breeding colonial waterbirds on the islands. The multiple ownership (private, state, and county) on these islands make future management possibilities a challenge. Preliminary Corps studies indicate that Willapa Bay contains one of the most

dynamic coastal inlets in the U.S., with high annual sediment movement (E. Nelson, Corps, pers. comm.). The possibility of re-creating Gunpowder Shoals and ensuring its stability is highly unlikely. Leadbetter Point at the northern tip of the Long Beach peninsula and the mouth of Willapa Bay may provide open sandy nesting habitat. Small numbers of gulls have nested here in the past. Heavy predator activity and erosion of the site have limited their success (K. Brennan, USFWS, pers. comm.), indicating that management for Caspian terns would be difficult.

Commencement Bay: In 2002, Caspian terns nested on the rooftop of a Port of Tacoma building. This colony most likely represented the same birds that were displaced from the ASARCO site in 2001 (see above). The Port of Tacoma plans to prevent the terns from nesting on the building in future years. The highly industrial and urbanized areas around Commencement Bay do not offer alternative nesting sites for this colony. This area lacks sandy shorelines free of mammalian predators and human disturbance. In addition, conflicts exist with two listed salmon stocks that occur in this bay (WDFW in litt.).

McNeil Island, South Puget Sound: McNeil Island, owned by WDFW, is a large island southwest of Commencement Bay in southern Puget Sound. No Caspian terns have been observed to nest here. The island contains a state correctional facility and some residential homes. The island was surveyed for large sandy beach areas that would be suitable for Caspian terns. No sites were found that would not require extensive habitat manipulation. Mammalian and avian (short-eared owl [*Asio flammeus*]) predation would also be an issue. In addition, the potential conflict from tern predation on migrating salmon smolts is high because the waters off McNeil Island are used by several species of salmonids, including two listed species (WDFW in litt.).

INTERIOR WASHINGTON

The Caspian tern colonies in east and central Washington are associated with reservoirs and lakes. This part of the state was once dominated by vast rolling tracts of sagebrush-steppe bisected by an occasional coulee (deep gulch or ravine, often dry in the summer). Since the time of European settlement, the uplands have been converted to dryland wheat and other agricultural crops. Several coulees were dammed forming irrigation reservoirs with islands suitable for Caspian tern nesting.

Currently, there are three Caspian tern nesting areas in the Interior Washington region: Banks Lake, Potholes Reservoir, and Sprague Lake (Figure 4). Sprague Lake is a natural lake, whereas Banks Lake and Potholes Reservoir are human-created. A fourth site on the Columbia River near Wallula, Washington will be discussed

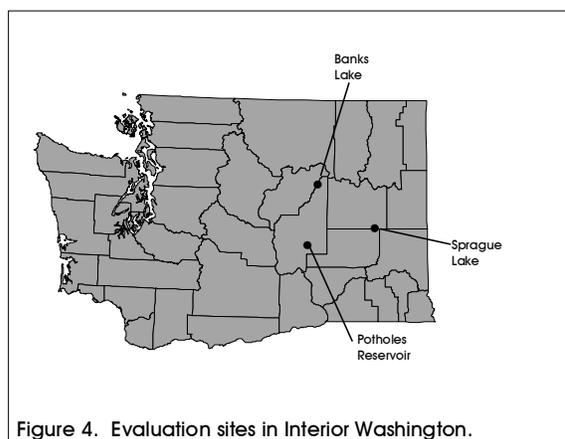


Figure 4. Evaluation sites in Interior Washington.

in the Mid-Columbia River section. Potential prey in Interior Washington include stocked sport fishes such as walleye (*Stizostedion vitreum*), largemouth (*Micropterus salmoides*) and smallmouth (*M. dolomieu*) bass, yellow perch (*Perca flavescens*), trout (*Oncorhynchus* spp.), and various centrarchids. There is evidence that some Caspian terns breeding at Potholes Reservoir are flying to the Columbia River to forage on salmonids (Ryan et al. 2002). Three salmonid species, including five Evolutionarily Significant Units, use the Upper Columbia River system (Table 3).

TABLE 3. Evolutionarily Significant Units of Salmonid Species in the Upper Columbia River system.

Species	Evolutionarily Significant Unit	Listing Status
Sockeye Salmon	Okanogan River	Not Warranted
	Lake Wenatchee	Not Warranted
Chinook Salmon	Upper Columbia River Summer/Fall	Not Warranted
	Upper Columbia River Spring	Endangered
Steelhead	Upper Columbia River	Endangered

Water levels, recreational use, and conflicts with endangered salmonids are the main management issues for Caspian terns in this region. Fluctuating water levels determine how much nesting habitat is available for nesting Caspian terns each year. Early in the nesting season, water levels are high, leaving only the upper portions of islands exposed for nesting. Because of large numbers of gulls, competition for nesting sites is probably strong between the species. Recreational boating, camping, and fishing may disturb nesting terns.

Currently, Caspian terns nest in the same three areas in Interior Washington they used historically. Colonies in both Banks and Sprague lakes have been relatively small (i.e., < 50 pairs in 1999, Shuford and Craig 2002). It is unknown if Caspian terns nested at these lakes in 2002. Caspian tern numbers at Potholes Reservoir are larger than at Banks and Sprague lakes, ranging from 5 pairs (1974) to 418 pairs (1989). Islands in Banks and Sprague lakes offer very little potential for Caspian tern management because of fluctuating water levels and substrate conditions.

Interior Washington Sites Without Management Potential

Sites assessed in the interior of Washington do not provide management opportunities for tern relocation because of the small size of the islands, limited nesting habitat, fluctuating water levels, human disturbance, and conflicts with endangered salmonids. The small and fluctuating size (~15 - 250 pairs), and dispersed locations of colonies in this region are characteristic of historic and current tern colonies in the inland ecosystems of the Pacific Coast/Western region. Conservation of these colonies through habitat protection and measures to limit disturbance is appropriate. However, given the potential impact of nesting Caspian terns in this region on Columbia River salmonids is unclear, active management to enlarge the colonies at these sites may not contribute to the goal of reducing the current impacts on salmonid species in the Columbia River.

Solstice Island: Solstice Island is in the northern portion of Potholes Reservoir, located just south of Moses Lake, Washington. The island is fairly well covered in shrubby, dense willow. In 2002, 170 pairs of Caspian terns nested on the east side of the island (C. Thompsen pers. comm.). The discovery of Passive Integrated Transponder (PIT) tags (used to identify salmon smolts) on the island confirms that Caspian terns forage to some degree in the Upper Columbia River (Ryan et al. 2002). However, the proportion of juvenile salmonids in the terns diet is unknown. Enlarging the colony at this site would not likely reduce current impacts on salmonid species in the Columbia River. In addition, the potential disturbance from recreational users at this site may be high and potentially affect tern reproductive success.

Unnamed Island, Potholes Reservoir: In recent years, Caspian terns have used an unnamed island in the northern portion of the reservoir. This unnamed island is approximately 1.6 km (1 mi) from Solstice Island. The island is covered in a mixture of shrubby willows, grasses, and forbs. During intermittent surveys of the colony in 2002, approximately 95 Caspian tern nests were observed (C. Thompson, WDFW, pers. comm.). Human disturbance is an issue at this site. It is suspected that all Caspian tern nests were destroyed during the Fourth of July holiday when levels of recreational activity are typically high (C. Thompsen pers. comm.). As with Solstice Island, it is likely that Caspian terns using this site may also travel to the Upper Columbia River to feed on salmonids.

Banks Lake: Banks Lake, near Coulee City, Washington, has three islands of volcanic rock with a thin layer of soil, that currently provide small areas of tern nesting habitat. Island vegetation ranges from grasses to small trees. Of these three islands, Goose Island, is the only one with recent use by Caspian terns; nesting was confirmed in 1997, and colony size has averaged 15-25 pairs. Approximately 600-1,000 pairs of California and ring-billed gulls use Goose Island and about 7,000 pairs use a second island to the south (near the dam). During spring, water levels are high with less of the islands exposed for colonial nesting birds. The limited water level and rocky substrate on the islands preclude substantial habitat enhancement for Caspian terns. Limited vegetation removal or placement of a better nesting substrate (sand) on the high points of the islands are about the only possible management options. These actions, however, would not significantly increase nesting habitat. Potential prey species for the terns appear to be diverse but there is no information on their abundance.

Harper Island: Harper Island is located in Sprague Lake near Sprague, Washington. This steep-sided 3 ha (7 a) island is covered mostly with grasses, shrubs, and small willows interspersed with small patches of bare substrate. Island substrate is mostly volcanic rock with a thin layer of soil. Caspian terns were first found nesting on the island in 1997; colony size has since ranged from 15-50 pairs. Not much can be done to improve Caspian tern nesting habitat because of the poor nesting habitat, the steepness of the island, and the rocky substrate.

MID-COLUMBIA RIVER

For the purposes of this report, the Mid-Columbia River region refers to the portion of the Columbia River between The Dalles, Oregon, and Richland, Washington. This stretch is 240 river km (150 river mi) in length, where the river flows south out of eastern Washington, turns west, and forms the border between Oregon and Washington. The uplands along this part of the

river were once covered with rolling tracts of mixed sagebrush-steppe and eastside grasslands (Crawford and Kagan 2001a,b). Since European settlement, the uplands have been converted mostly to dryland wheat and other agricultural crops.

Three dams occur on the Mid-Columbia River: The Dalles, John Day, and McNary. The impounded water behind The Dalles and John Day dams have created islands, most of which are basaltic. The exception are the islands near Boardman, part of the Umatilla NWR, which are composed of gravel, sand, and silt. Caspian terns have nested on Miller Rocks (The Dalles Pool) and Three-mile Canyon Island (John Day Pool), in the lower section of the Mid-Columbia River, and on Crescent Island, one of several islands behind the McNary Dam in the upper portion of the Mid-Columbia (Figure 5). Although Caspian terns were seen along the Mid-Columbia River in 2002, the only nesting colony was located on Crescent Island.

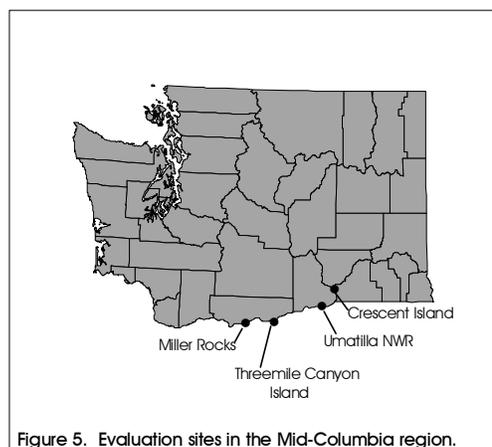


Figure 5. Evaluation sites in the Mid-Columbia region.

Although Caspian terns were seen along the Mid-Columbia River in 2002, the only nesting colony was located on Crescent Island.

The primary management issue in this region is the potential impact of tern predation on salmonids. Three salmonid species, including 12 Evolutionarily Significant Units use the Mid-Columbia River during various life stages (Table 4). There are also several sport fish species in the river: walleye, largemouth and smallmouth bass, and introduced carp (*Cyprinus carpio carpio*). Diet studies of tern colonies on Crescent and Threemile Canyon islands found salmonids to be the dominant prey (61% and 81%, respectively; Collis et al. 2002b).

Other management issues include habitat availability and predators. Vegetation encroachment into nesting areas is an ongoing issue. Suitable nesting habitat is limited and further diminished by competition and predation by nesting gulls. Some islands also have rookeries of black-crowned night-herons (*Nycticorax nycticorax*), which are also potential predators on tern nests.

TABLE 4. Evolutionarily Significant Units of Salmonid Species in the Mid-Columbia River system.

Species	Evolutionarily Significant Unit	Listing Status
Sockeye Salmon	Snake River	Endangered
	Okanogan River	Not Warranted
	Lake Wenatchee	Not Warranted
Chinook Salmon	Snake River Fall	Threatened
	Snake River Spring/Summer	Threatened
	Upper Columbia River Spring	Endangered
	Upper Columbia River Summer/Fall	Not Warranted
	Mid-Columbia River Spring	Not Warranted
Steelhead	Upper Columbia River	Endangered
	Mid-Columbia River	Threatened
	Snake River Basin	Threatened

Mid-Columbia River Sites Without Management Potential

As with the Interior Washington sites, colonies in the mid-Columbia river are relatively small in size because of limited habitat. In 2001, counts ranged from a low of 2 pairs on Threemile Canyon Island to a peak of 720 pairs on Crescent Island. Nesting habitat is restricted by the small size of the islands, vegetation, lack of suitable substrate, and nesting gulls. Data collected in 1979 and 1997-2002 indicate annual variation in numbers of breeding terns but no significant growth in colony size since they were established or monitored. The colony on Threemile Island in 2000 and 2001 did not successfully produce young and was completely abandoned in 2002. Management potential on these sites is limited by habitat availability, mammalian and gull predation, and possibly competition for nesting area with gulls. These colonies are representative of the small and well dispersed colonies traditionally found throughout the interior of the Pacific Coast/Western region. Although conservation of these dispersed colonies through habitat protection and measures to limit disturbance is appropriate, active management to enlarge the Caspian tern colonies in the mid-Columbia will not contribute to the goal of reducing impacts to listed salmonids of the Columbia River. Thus, none of these sites are considered to have management potential.

Crescent Island: Crescent Island, a dredge-spoil island built in 1985, is near the confluence of the Snake and Columbia rivers at river mile (RM) 316. It is relatively flat and heavily vegetated with Russian olive (*Elaeagnus angustifolia*), cottonwood (*Populus spp.*), willow, and grass. Caspian terns nest on a 0.04 ha (4,800 sq. ft) area on the northeastern end of the island; recent nesting numbers have ranged from 356 pairs in 1998 to 720 pairs in 2001 (Shuford and Craig 2002). The island is owned by the Corps but managed through a cooperative management agreement with McNary NWR. Studies at this colony in 2002 documented the tern diet to be 67% salmonids (Collis et al. 2002b). Enlarging the colony of Caspian terns at this site would not reduce current impacts on salmonid species in the Columbia River. Thus, actively managing the site to attract terns from East Sand Island is not appropriate.

Umatilla NWR: Several islands near Irrigon, Oregon, are within the Umatilla NWR around RM 274. Many of them are small, i.e. 0.1 - 1.2 ha (0.3 - 3 a). These islands are low and flat and composed of cobble, sand, or silt; some are heavily vegetated, primarily with introduced false indigo (*Baptisia australis*). The Refuge has recently implemented a program to eliminate false indigo from some of the islands. If successful, open sand and cobble bars may be available for nesting terns. A small number of Forster's terns (<50 pairs) nest on several of these islands, but no Caspian terns have been observed nesting in this area. A small number of adults and fledglings were observed in the area in 2002. These small islands likely would not support a large colony of Caspian terns, and active management to attract terns to this area would not support the goal of reducing impacts to salmonids in the Columbia River.

Threemile Canyon Island: Threemile Canyon Island, along the southern edge of the Columbia River at RM 253 east of Arlington, Oregon, is a natural island with a berm built from dredge material to provide a wind/channel barrier for a public boat ramp and waterfowl habitat (Shuford and Craig 2002). The island is heavily vegetated with various species of trees (willow, mulberry

[*Moraceae spp.*]), false indigo, sagebrush, grasses, and forbs. Caspian terns were found nesting on the island as early as 1977 (184 pairs); annual counts from 1997 to 2000 ranged from 200 to 400 pairs (Shuford and Craig 2002). In 2000, no young were produced at the site because of mink predation. Few terns returned to nest in 2001 and none in 2002. The Caspian tern diet at this site in 1997-1998 was 81% salmonids (Collis et al. 2002a). Heavy mink predation and the high salmonid consumption by terns precludes this island as a potential enhancement area for Caspian tern nesting.

Miller Rocks: Miller Rocks, associated with Miller Island, are three bare islands of basalt rock near the mouth of the Deschutes River at RM 207. These rocks host a large California and small ring-billed gull nesting colony. The gulls dominate the site, leaving little area for Caspian terns. A small number of terns (~15 pairs) nested at this site in 2001 (Shuford and Craig 2002). These birds were suspected to be re-nesters relocating after a colony failure that year at Threemile Canyon Island. No nesting terns were observed at Miller Rocks in 2002. As nesting habitat is limited and no habitat management options are available, this site has very limited potential for enhancement for Caspian terns.

COASTAL OREGON

The Oregon coast has 21 principal estuaries (Gaumer et al. 1985, O’Mealy and Johnson 2001), which range in size from the 37,952 ha (93,782 a) Columbia River estuary in the north to the 53 ha (130 a) Winchuck estuary in the south (Bottom et al. 1979). The ecological characteristics of Oregon estuaries vary significantly in terms of river flow, depth, salinity, mixing, sediment composition, and shape (Bottom et al. 1979), as do the biological communities within them.

On most of the Oregon coast, the Caspian tern is a common transient in the spring (late March to late May) and summer (late June to early September, Gilligan et al. 1993). During June, Caspian terns are generally scarce along the coast except within and around the Columbia River estuary (Gilligan et al. 1993). Caspian terns are known to have nested on the Oregon coast only in the Columbia River estuary. Major habitat changes in the estuaries (diking of tidal marshes, channel dredging, jetty construction) and watersheds (logging, urban and agricultural development) along the Oregon coast have created potential tern nesting habitats in the form of sediment deposition islands, dredge-spoil islands, jetties, and dikes.

On the basis of a habitat assessment from an aerial survey, it was determined that only two estuaries contained sites that might serve as nesting habitat for Caspian terns. Several estuaries contained islands that appeared during low tide periods only or would be inundated by extreme

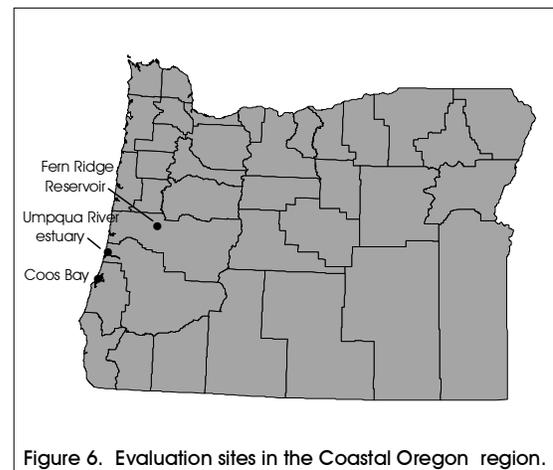


Figure 6. Evaluation sites in the Coastal Oregon region.

high tides, whereas others did not contain any potential tern habitat. Although located inland, the Fern Ridge Reservoir is included in this regional discussion (Figure 6).

The two estuaries that do contain potential habitat for Caspian terns are Coos Bay and the Umpqua River estuary (Figure 6). These sites are less than 40 km (25 mi) apart and have similar habitat types. Both are considered drowned river estuaries (ones that usually retain the form of a valley in their cross-section, allowing a great deal of tidal flushing; Oregon Coastal Conservation and Development Commission 1974). Both estuaries are large, drain considerable acreage, and contain several islands that could potentially be enhanced to develop suitable nesting habitat for Caspian terns.

The main management issue for both estuaries is the potential conflict from tern predation on migrating salmon smolts. Coho and chinook salmon, steelhead, and coastal cutthroat trout (*O. clarki clarki*) use the estuaries during various life stages (Table 5). Chum salmon is also occasionally found within Coos Bay. Unlike the Columbia River estuary, which harbors seven runs of listed salmonids, the two estuaries considered here host only one federally listed salmon, the coho (Table 5). The steelhead is currently a candidate for federal listing. ODFW opposes relocating Caspian terns to non-historical sites (all sites discussed in this section) because of concerns that relocation would result in the same predation risks on sensitive or listed stocks as was found in the Columbia River estuary.

Table 5. Evolutionarily Significant Units of Salmonid Species in the Coastal Oregon region (including Fern Ridge Reservoir).

Species	Evolutionarily Significant Unit	Listing Status
Coho Salmon	Oregon Coast	Threatened
Steelhead	Oregon Coast	Candidate
	Upper Willamette River	Threatened
Chinook Salmon	Oregon Coast	Not Warranted
	Upper Willamette River	Threatened
Chum Salmon	Pacific Coast	Not Warranted
Coastal Cutthroat Trout		Not Warranted

Coastal Oregon Sites With Management Potential

Unnamed Island, Coos Bay

Site Description

Across the Coos Bay estuary from Empire, Oregon, is a small bar-bell-shaped island owned by the Oregon Division of State Lands. The high points at each end of the island have some small areas of established vegetation that are above the high tide mark. Vegetation cover on these areas is about 30% trees, 30% shrubs, and 40% grasses. There is also a small patch of trees between the high points near the downstream end of the island. At low tide the area between the island and the mainland shore is less than 150 m (492 ft) across and shallow; at extremely low

tides, the island may have a land-bridge to the shore. The island appears to be a stable natural island comprised of sand and silt. It is approximately 0.6 ha (1.5 a) in size and about 1 to 2 m (3-7 ft) above the water line. Caspian terns have not been documented nesting on the island but they are present in the bay sporadically throughout the summer. The island is located in the saltwater zone of the estuary downstream from an area where salmon smolts are believed to go through the smoltification process, when they are most vulnerable.



Downstream end of the island.

Prey Base

Potential prey species include various salmonids and a variety of marine fish, including sardine, anchovy, smelt, and American shad (*Alosa sapidissima*).

Management Issues

The primary management issues for this site are the potential conflict with tern predation on migrating salmon smolts, vegetation management, potential land predators, and human disturbance. Several salmonids use Coos Bay during various life stages (Table 5). Given the island is located near the mouth of the estuary, there likely is a high availability of marine fish prey. In addition, a tern colony here would be significantly smaller (because of habitat limitations) than at East Sand Island and therefore potential effect on salmonids would likely be substantially less than in the Columbia River estuary.

Vegetation on the island would need to be removed to provide open nesting habitat for terns. In addition, the channel between the island and the mainland is very shallow, potentially allowing easy access to mammalian predators. Another possible management issue is human disturbance to nesting terns from heavy All Terrain Vehicle (ATV) use along the north shore on weekends.

Opportunities and Needs

This island has good potential for enhancement for nesting Caspian terns. The small size of the island would limit the number of nesting terns thereby minimizing potential impacts on salmonids. The small amount of vegetation removal needed could be done mostly by hand. A small amount of dredging along the north side of the island would increase the area available to terns and reduce predator access to the island. As a side benefit, the habitat created for Caspian terns might also be used by the threatened coastal population of the western snowy plover (*Charadrius alexandrinus nivosus*); some plovers currently nest along the coastal foredunes directly to the west of the island. Development of management plans and associated environmental review documents of any proposed project would involve key agencies such as ODFW, Oregon Division of State Lands, USFWS, and the Corps. Any proposed project would require Endangered Species Act compliance.

Umpqua River Estuary

Two islands in the Umpqua River estuary are discussed together in this section because their physical characteristics, prey base, and management issues are similar.

Site Descriptions

Unnamed Island: Upstream from Winchester Bay, Oregon, is an unnamed island near the north shore of the estuary immediately adjacent to Dunes National Recreation Area (RM 6). The State of Oregon owns this 12 ha (30.5 a) island (measured at the low tide line; Douglas County Planning Office, Coastal Planning). The 2 ha (5 a) above the high tide mark are covered with short shorepine (*Pinus contorta*) and Sitka spruce (*Picea falcata*) trees (40%), shrubs (20%), and grasses (40%). The island is composed of sandy soil and appears to be stable. A berm of unknown origin, outlined by trees, rings the high portion of the island, which is gentle rolling terrain (see aerial photo). From the



Unnamed Island, Umpqua River Estuary

air, it is apparent that the Umpqua River glances off the sharp bend to the north and flows south along the east face of the island, thereby inhibiting the establishment of emergent vegetation at any great level in this area. This provides a sandy beach on the island adjacent to a 0.5 ha (1.2 a) area of mostly grass. A lack of prior nesting on the islands by Caspian terns likely reflects the extensive vegetation. Caspian terns, however, are present in the estuary sporadically throughout the spring and summer months.



North end of Steamboat Island

Steamboat Island: Steamboat Island, owned by the Port of Umpqua, is just downstream from the Highway 101 bridge at RM 8. Only the northern 1-2 ha (2.5-5 a) of the island is far enough above the high tide mark to be suitable for nesting terns. This area is heavily vegetated in Scotch broom and blackberry, and has small areas of alder (*Alnus spp.*). Historically, the island has been grazed by sheep. The island has also been used as a dredge spoil site when the channel was deepened for the ship *Hero*, but most of this material was placed toward the center of the island (Douglas County Planning Office, Coastal Planning). It is unclear if the northern part of the island was used as a dredge spoil

site or naturally created by drifting sand from what is now the Dunes National Recreation Area. The northern end of the island appears to be composed mostly of sand; some erosion is occurring along the steep north bank.

Prey Base

Potential prey species include salmonids, sardine, anchovy, smelt, and shad. In addition, on a tributary of the upper reaches of the Umpqua River is the only state-owned fish hatchery within the Umpqua River drainage. The Rock Creek Fish Hatchery, located ~200 km upriver from the mouth of the estuary, raises coho and spring chinook salmon, steelhead, and rainbow trout, which migrate through the estuary (<http://www.dfw.state.or.us/ODFWhtml/FishProp/fishprop.html>).

Management Issues

The primary management issues for the Umpqua River estuary sites are potential conflict from predation on migrating salmon smolts and available stable nesting habitat. As in Coos Bay, the great availability of marine fish and small colony size (limited by habitat) would most likely result in substantially less potential impact on salmonids in the estuary than that observed in the Columbia River estuary.

Vegetation on both islands could be removed to provide open habitat for nesting terns. Vegetation removal at Steamboat Island, though, might increase the erosion currently occurring along the north side of the island. Some recreational boating and fishing occurs near the island, which might be disturbing nesting terns. Another potential issue is associated with a large double-crested cormorant roost site on nearby Bolan Island. Many of the roost trees are in the process of dying and in a few years the birds will need to establish a new roost site, possibly on these islands; if so, this might eliminate nesting habitat for Caspian terns.

Opportunities and Needs

Of all the sites surveyed along the Oregon coast, the unnamed island in the Umpqua River provides the best management opportunity for Caspian terns. Habitat enhancement required at this island is minimal, and its location down river from the area where salmon smolts are believed to go through smoltification is likely to reduce the potential impacts on salmonids. Enhancement activities would probably require heavy equipment. For Steamboat Island, however, further review would be needed to evaluate whether vegetation removal might jeopardize the stability of the island's substrate.

Although water surrounds the unnamed island on all sides, at low tide it appears to be shallowest on the west side. It is unclear if the west side channel is wide or deep enough to inhibit access of mammalian predators, and, hence, dredging might be needed to encourage isolation of the tern colony. Development of management plans and associated environmental review documents of any proposed project would involve key agencies such as Port of Umpqua (landowner), ODFW, Oregon Division of State Lands, USFWS, and the Corps. Any proposed project would require Endangered Species Act compliance.

Fern Ridge Reservoir

Site Description

Fern Ridge Reservoir on Long Tom River, a tributary of the Willamette River near Eugene, Oregon, is a shallow flood control reservoir. Currently, there is no Caspian tern nesting habitat at the reservoir. In 2000, the Corps prepared a conceptual draft plan that proposes constructing a 0.4 ha (1 a) Caspian tern nesting island. The proposed site is on the southeast side of the reservoir off Royal Avenue. The conceptual draft plan describes the island as square in shape for simplicity of construction. Cost of the project was estimated to be \$172,500. This conceptual draft plan was prepared as part of a 16 ha (40 a) winter sub-impoundment project. This project was deferred pending more comprehensive review of Caspian tern management needs (G. Dorsey pers. comm.).



Proposed site for island construction.

Prey Base

Fern Ridge Reservoir supports a large population of common carp along with bullhead catfish and various sunfish (e.g., largemouth bass, black and white crappie, bluegill, etc.; Corps of Engineers Conceptual Draft). The Willamette River, about 14 km (9 mi) to the east, supports federally threatened Upper Willamette River chinook salmon and steelhead that also could be potential prey for Caspian terns.

Management Issues

The primary management issue at this site is potential conflict of tern predation on migrating salmonid smolts in the Willamette River. The main smolt migration period around Eugene, Oregon, occurs from about mid-March to early June (B. Meyer pers. comm.). ODFW has set their windows for instream work for June 1 to September 30 from Yamhill to McKenzie River and June 1 to October 31 for the Willamette River above the McKenzie River. This suggests that there may be some overlap of the tern breeding season and the smolt outmigration; however, the peak of smolt out-migration would have passed before the peak of the Caspian tern chick-rearing period.

Opportunities and Needs

Caspian terns have been observed migrating north and south through the Fern Ridge Reservoir area. Thus the reservoir provides an opportunity for creating an island in the flight path of Caspian terns heading to and from the Columbia River. The Corps has already completed a conceptual draft discussing the design features and cost estimates for creating a 0.4 ha (1 a) island. Development of management plans and associated environmental review documents of the proposed project would involve key agencies such as ODFW, USFWS, and the Corps. Any proposed project would require Endangered Species Act compliance.

Coastal Oregon Sites Without Management Potential

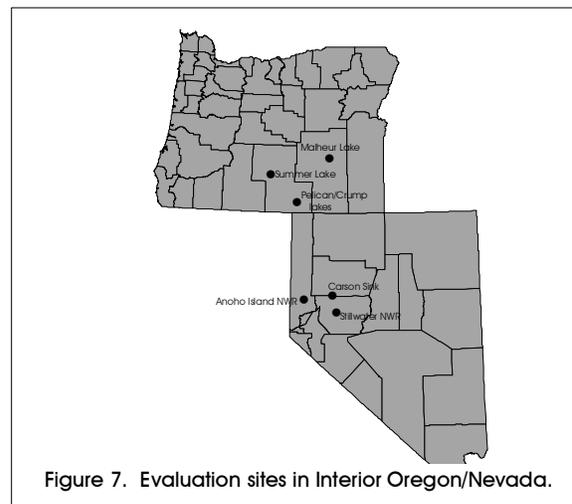
Coos Bay: Just off the waterfront of Coos Bay are three islands, referred to as “North,” “Middle,” and “South” islands in the field forms. These are old dredge-spoil islands owned by the Port of Coos Bay. They vary in size from 2-6 ha (5-9 a) each, range from 2-5 m (7-16 ft) in elevation above the average water line, and are generally covered with trees, shrubs, and grasses. Many of the management issues related to salmon smolts and vegetation control for these islands are similar to those discussed previously in the Sites with Management Potential section. However, migrating salmon smolts probably stage near these three islands, thereby increasing the potential effects of tern predation. Human disturbance is also a potential issue at these islands. Heavy boat traffic, shipping traffic (wood chips), frequent fishing fleets, and personal watercraft, pass on the west side of the islands. Annual Fourth of July celebrations involving fireworks set to detonate over the islands most likely would disturb nesting terns, especially chicks. The constant boat activity, fireworks, and salmon issues preclude these three islands from providing management opportunities for Caspian tern nesting habitat.

Tillamook Bay: This bay was surveyed for islands that remain above the high tide waterline, but no such islands were found. Many of the areas that remain exposed above normal high tide were part of the high salt marsh that is flooded during extremely high seasonal tides. These areas were covered with dense grasses and were bisected with deep sloughs. Thus, this bay did not contain opportunities for Caspian tern management.

INTERIOR OREGON/NEVADA

Caspian tern colonies in southeastern Oregon and northwestern Nevada are found mainly in shallow lakes and flooded playas in terminal basins. These sites are within a mosaic of habitats, including wetlands (tule cattail marsh, seasonally wet meadows), salt grass meadows, and salt desert and sagebrush shrublands. Pyramid Lake, Nevada, is different from the other sites. It is a natural deep water terminal lake (108 m [354 ft] deep) fed by the Truckee River, which flows from Lake Tahoe.

Currently, there are three Caspian tern nesting areas in this region: Malheur and Summer lakes, and the Pelican/Crump lakes complex, Oregon; and Carson Sink, Pyramid Lake, and Stillwater Point Reservoir, Nevada (Figure 7). All of these lakes are located within terminal basins, fed primarily by snowmelt. Primary prey species for terns in these areas are introduced carp, redband trout (*Oncorhynchus mykiss newberrii*), Lahotan cutthroat trout (*O. clarkii*, Pyramid Lake), and tui chub (*Gila bicolor*). Maintenance of adequate water levels is the main management issue in all of the sites listed



except Pyramid Lake. Lakes and wetlands in this area are filled by natural springs and runoff and are particularly prone to irregular flooding and prolonged droughts. Consequently, water levels fluctuate greatly, leading to high year-to-year variation in the availability of nesting areas for Caspian terns and in prey availability.

Historically, Caspian terns nested in these same areas in interior Oregon and Nevada. Colonies at both Summer and Pelican/Crump lakes have been relatively small, with peaks of 50 and 150 pairs, respectively. The colony at Malheur Lake attained a peak of 600 pairs in 1994, but nesting numbers have dropped dramatically in recent years, apparently in response to drought conditions (Shuford and Craig 2002). During 1999 (a post-flood year), approximately 685 pairs of Caspian terns used three small islands in Carson Sink, Nevada. The Caspian tern colony at Anaho Island reached a peak of 95 pairs in 1995. The last report of Caspian terns breeding at Stillwater Point Reservoir was of 5 pairs in 1977 (Shuford and Craig 2002).

Interior Oregon/Nevada Sites Without Management Potential

As indicated above, the availability of nesting habitat in this region is highly variable because of natural cycles of flood and drought, and, thus, stable long-term nesting habitat for Caspian terns is lacking. These sites do not have the capability for managing water levels. Given the inability to provide a stable nesting habitat or forage base annually, all of the sites within this region have very limited management potential for relocating Caspian terns from the Columbia River estuary. However, conservation of these sites through habitat protection and enhancement is appropriate by efforts to provide suitable nesting habitat during periods with the right water conditions.

Malheur Lake: Malheur Lake lies in the Harney Basin at the northern limit of the Great Basin. Caspian terns were first documented breeding there in 1917. Colony size and location varies greatly depending on cycles of drought and flood. Peak numbers of 600-650 pairs were recorded in 1994-1995, but declined thereafter (Shuford and Craig 2002). In 2000-2001, birds nested at two locations: Tern Island (within Malheur NWR) and an unnamed island (on private property) at the north end of Malheur Lake. These two islands are comprised of sand and silt with very little vegetation. Water conditions, determined primarily by annual precipitation, are the main factors affecting availability of nesting islands and the preferred prey of Caspian terns at this site (Ivey pers. comm.). During normal water years, nesting habitat is not limiting. During low water years, though, nesting islands become connected to the mainland, allowing access by mammalian predators, and prey is most likely limited. Prey availability and abundance appear to respond to water conditions; prey do not seem to reach the optimal size for Caspian terns until several years after re-flooding following drought (Ivey pers. comm.). Lacking a way to control water levels within the lake, very little can be done to improve or ensure annual availability of tern nesting habitat. Efforts can be made, however, to enhance the current habitat so that it will be suitable in years with the right water and prey conditions.

Pelican and Crump lakes: Pelican and Crump lakes lie within the Warner Valley east of Lakeview in southern Oregon. Pelican Lake is privately owned and Crump Lake is owned by multiple owners (federal, state, and private). Caspian terns (6 pairs) were first documented nesting on one of two islands in the northern portion of Crump Lake in 1987 (Stern 1988). Very few data are available on nesting Caspian terns at these sites. A peak of 150 pairs was observed in 2000. It appears that Caspian terns move between islands in Pelican and Crump lakes depending on water levels and which islands are exposed (C. Carey, ODFW, pers. comm.). The islands in Crump Lake are composed primarily of gravel with patches of saltgrass or Baltic rush (Stern 1988) and are completely flooded at high water levels. The islands in Pelican Lake are composed of compacted lakebed sediments with scattered greasewood shrubs and saltgrass (Stern 1988), and portions of the islands usually stay above the high water line (C. Carey, ODFW, pers. comm.). These islands are very small, less than 0.1 ha (.25 a) and thus provide limited nesting habitat. New islands could possibly be created but, as with Malheur Lake, irregular water conditions most likely result in cyclic prey availability.

Summer Lake: Summer Lake is located in Lake County, Oregon, northwest of Pelican and Crump lakes. Much of Summer Lake is within the Summer Lake Wildlife Area managed by ODFW. During low water levels, one large island is exposed in the northern portion of the lake (M. St. Louis, ODFW, pers. comm.). During high water levels, this large island becomes several smaller islands that are used by colonial nesting waterbirds. Total island area ranges from 2-4 ha (5-10 a). The islands are composed of silty soils with a few small boulders. Data are lacking on annual Caspian tern use at this site, but all recent estimates have been less than 50 pairs (Shuford and Craig 2002). In 2000, only 16 pairs were observed. As with Malheur Lake, nesting habitat at Summer Lake is heavily dependent on water levels. Again, the lack of a way to control water levels within the lake preclude improving tern nesting habitat or ensuring its annual and long-term availability.

Carson Sink and Stillwater Point Reservoir: Both of these sites are located near Stillwater, Nevada. Like most Great Basin lakes and wetlands, these two areas are dependent upon the winter snowpack. After a heavy snowpack, melt water floods the basins and fish populations expand. During such times these areas are available for nesting Caspian terns. The islands are composed mostly of silt and gradually rise toward the center. Little vegetation exists on the Carson Sink islands, but the island in Stillwater Point Reservoir has a cover of salt cedar (*Tamarix ramosissima*), grasses, and forbs and is surrounded by bull rushes (2-3 m [7-13 ft]). The latter island is also used by nesting white-faced ibis (*Plegadis chihi*), cattle egrets (*Bubulcus ibis*), black-crowned night-herons (*Nycticorax nycticorax*), and snowy (*Egretta thula*) and great (*Ardea alba*) egrets. The arid nature of the Great Basin and the irregular intervals of high water interspersed with drought conditions preclude options for actively managing for Caspian terns on these sites.

Anaho Island, Pyramid Lake: Anaho Island is about 300 ha (741 a) in size of which 100-200 ha (250-500 a) are suitable nesting habitat. Anaho Island is part of the Pyramid Lake Paiute Indian Reservation and is managed as Anaho NWR. It is composed of sand, gravel, and rock and rises over 300 m (980 ft) above lake level. American white pelicans (*Pelecanus erythrorhynchos*), double-crested cormorants (*Phalacrocorax auritus*), California gulls, and great blue herons

(*Ardea herodias*) use this island as a nesting site. Caspian tern colonies on Anaho have ranged in size from 5-125 pairs. Typically, few fish of adequate size are available to support breeding terns; most are larger and thus, more suitable for the larger colonial nesting birds that use Pyramid Lake. Although prey base here may limit the size of the tern population, nesting habitat is extensive (B. Henry pers. comm.).

SOUTHERN IDAHO

Topography in southern Idaho includes a complex of valleys and plains interspersed with foothills and mountains. The terrain is gentle to rugged depending on various fluvial, volcanic, and erosional processes (Hann et al. 1997). Vegetation is dominated by sagebrush, juniper, and salt desert shrub. Much of this area has been converted for agriculture and grazing. Caspian terns are found in this region primarily at reservoirs and lakes.

There are six locations in southern Idaho at which Caspian terns have nested: Mormon, Magic, American Falls, and Blackfoot reservoirs, Minidoka NWR, and Bear Lake NWR (Figure 8). Except for Bear Lake and Mormon Reservoir, these sites are located along the Snake River or its tributaries. These are all small colonies, ranging from 4 - 50 pairs. Potential prey species include young carp, cutthroat and rainbow trout, sunfish (Centrarchidae), and Utah chub (*Gila atraria*).

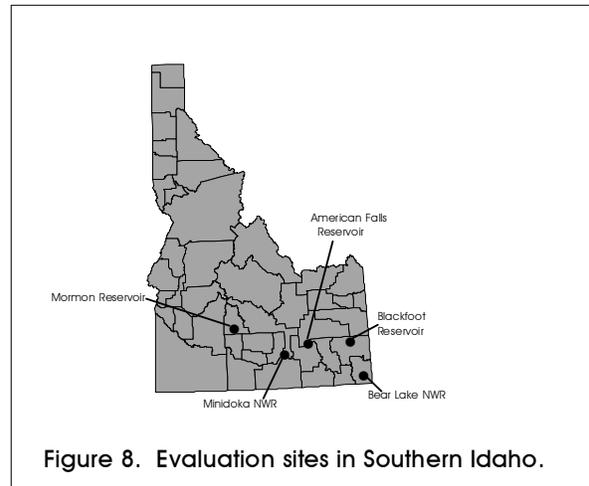


Figure 8. Evaluation sites in Southern Idaho.

Availability of nesting habitat is the main management issue at southern Idaho sites. Reservoir water levels fluctuate through the seasons and determine the available nesting habitat and prey resources for terns. Most often, low water levels connect islands to the shoreline, creating access for mammalian predators. Nesting islands at Minidoka and Bear Lake NWRs are stable but heavily used by other colonial nesting waterbirds, limiting habitat for Caspian terns.

Magic Reservoir has been dry for the last 2 years, and terns have not been observed nesting at Bear Lake for many years (D. Sjoström pers. comm.). New colonies were discovered in 2002 at American Falls and Blackfoot reservoirs, north of Bear Lake NWR. In 2002, colonies at Minidoka NWR and American Falls Reservoir were both less than 10 pairs, whereas those at Blackfoot and Mormon reservoirs were 50 and 25 pairs, respectively.

Southern Idaho Sites Without Management Potential

As with the Interior Oregon and Nevada sites, the presence of islands in Southern Idaho is highly variable because of fluctuating water levels in the reservoirs, which do not provide stable, long-term nesting habitat for Caspian terns. In addition, colonies in Southern Idaho are on the eastern fringes of the Pacific Coast/Western region and small in comparison to others in the region. Given the distance from East Sand Island, it would be difficult to attract terns to these sites because the likelihood of terns encountering these sites enroute to East Sand Island are low. Given all these factors, none of the sites in southern Idaho have management potential to serve as alternative nesting habitat for Caspian terns from East Sand Island.

Bear Lake NWR: Caspian terns have nested on a small stable island on Mud Lake, within Bear Lake NWR in southeastern Idaho near Montpelier. In recent years, terns have been present but no nesting has been observed. The less than 0.01 ha (200 sq. ft.) island is comprised of bare alkaline soil with low forbs. Double-crested cormorants and California gulls, which have nested on the island for the last 10 years, dominate the island and appear to prevent the terns from breeding by limiting habitat available for the terns (D. Sjostrom pers. comm.).

Gull Island, Blackfoot Reservoir: Gull Island, in Blackfoot Reservoir north of Bear Lake NWR, is a large rocky (basalt) island with a low, flat area on the north end. Terns were first observed nesting in this area in 2002, when 90 adults and 50 nests were observed (C. Trost pers. comm.). A large California gull colony (~10,000 pairs) nests near the tern nesting area, potentially limiting the area available for terns (C. Trost pers. comm.). Gulls, black-crowned night herons, and great blue herons are all potential predators. If reservoir levels drop too low, the island connects to the shoreline, allowing access for mammalian predators. However, predators may not be a problem as evidenced by the large nesting gull colony. The small nesting area is a limiting factor for this site.

Gull Island, American Falls Reservoir: American Reservoir is west of Blackfoot Reservoir. Adult Caspian terns were first observed nesting in the reservoir in 1984 (two pairs), but no annual surveys have been conducted to monitor this colony (Shuford and Craig 2002). In 2002, five pairs were observed nesting on Gull Island (C. Trost pers. comm.). Given the reservoir dried up by July, it is likely that all tern nests failed. The inability to control water levels, and possibly prey resources, limit the potential for enhancement of tern nesting habitat.

Tern Island, Minidoka NWR: Tern Island is a low rock island near two larger islands with nesting American white pelicans and double-crested cormorants. The numbers of nesting Caspian terns at this site has always been low (< 5 pairs; Shuford and Craig 2002). In contrast, the numbers of nesting cormorants and pelicans have been increasing in the last 10 years (S. Bouffard pers. comm.). Fledgling pelicans and cormorants like to use Tern Island as a roost site and appear to overwhelm any nesting Caspian terns. Thus, even though this site is stable, the growing pelican and cormorant colony and, possibly, prey resources are likely limiting factors.

Mormon Reservoir: Mormon Reservoir is a small reservoir located in central southern Idaho south of Sun Valley. Caspian terns nest on a small unnamed island dominated by a large

California gull colony. Nesting Caspian terns were first documented in 1984 (10-15 nests; Shuford and Craig 2002). In 2002, 25 pairs were observed breeding. Similar to other Southern Idaho sites, the small nesting area and limited prey resources are likely limiting factors.

NORTHERN COASTAL CALIFORNIA

For the purposes of this report, the Northern Coastal California region includes areas from Monterey Bay north to the Oregon border. Caspian tern colonies are found in this region in San Francisco, Monterey, and Humboldt bays. In San Francisco Bay, terns currently nest on human-created islands in active or historic salt ponds, on a sandy spit of a large natural island (Brooks Island), and on an insular portion of a dilapidated pier. In Humboldt Bay, terns have nested intermittently on islands in the Arcata Bay (north) arm. In Monterey Bay, terns have nested irregularly since 1970 on an eroded levee island or peninsula at a set of abandoned salt ponds, two islands within Elkhorn Slough, and on a beach near a lagoon or pond at the Salinas River mouth (Shuford and Craig 2002).

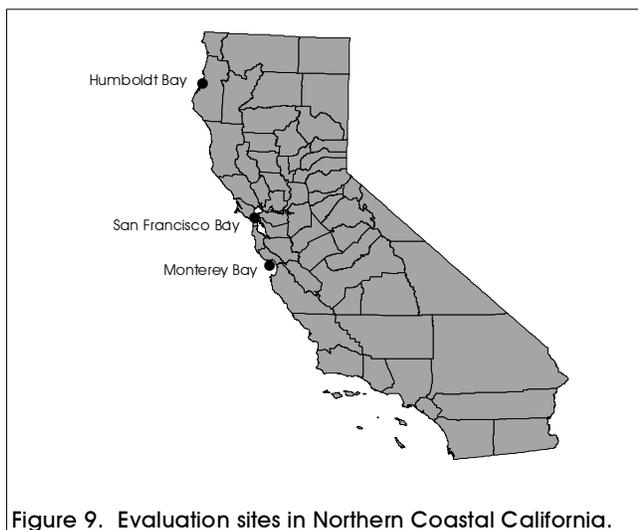


Figure 9. Evaluation sites in Northern Coastal California.

San Francisco Bay, the largest estuary in California, contains various habitats bordering extensive urban development.

Habitats include deep and shallow bays, tide flats and associated salt marshes, diked wetlands, salt ponds, and diked agricultural lands. Artificial salt ponds, created for commercial salt harvest, comprise 16,200 ha (40,031 a; Takekawa et al. 2000). These salt ponds are large, shallow impoundments in tidal salt marsh systems that undergo a sequence of infrequent flooding with saline or brackish bay waters (Baye 2000). Some of these salt ponds are no longer actively harvested, and many support large numbers of waterbirds. Islands located within these salt ponds are usually old levees from former operations. However, some have been constructed to impede wave action that might otherwise cause dike erosion.

Except for a lack of salt ponds, Humboldt Bay, has a suite of habitat similar to San Francisco Bay. Humboldt Bay is the second largest estuary in California and is immediately surrounded by lowlands, formerly marshy extensions of the bay, which were diked and drained for agricultural use, primarily grazing, beginning in the 1880s (Barnhart et al. 1992). Monterey Bay, located south of San Francisco, is half-moon shaped with a deep submarine canyon. This bay is very different from the others described here in that it isn't an estuary but rather a semi-protected stretch of coastal waters.

Food resources are readily available in these bays and do not appear to be limiting. Potential prey resources in Northern California include Pacific herring, northern anchovy, jacksmelt, and salmonids (Goals Project 2000). Four species of salmonids, including 11 Evolutionarily Significant Units, occur in San Francisco, Humboldt, and Monterey bays (Table 6). A study in 1971, documented the diet of Caspian terns at one colony in San Francisco Bay. Of the 605 fish found at the colony site, less than 1 % were salmonids (Gill 1976). Major management issues at Northern California sites include providing stable, predator-free nesting habitat and, perhaps, water quality/contaminant concerns. Contaminants such as lead, copper, mercury, petroleum, and pesticides may be found throughout San Francisco Bay (Goals Project 1999). Thus, contaminant uptake by terns is possible and may potentially reduce reproductive success. Currently, a USFWS study is investigating whether contaminant presence in San Francisco Bay affects Caspian tern reproductive success. CDFG has concerns that increasing existing Caspian tern colonies would potentially impact other listed species such as the California least tern (*S. antillarum browni*) or the western snowy plover, primarily by displacing these species in nesting areas (CDFG in litt.). To minimize potential impacts, any proposed project would require Endangered Species Act compliance if listed species occur in the project area. Other CDFG concerns include potential impacts on salmonids and marine prey resources.

TABLE 6. Evolutionarily Significant Units of Salmonid Species in the Northern California region.

Species	Evolutionarily Significant Unit	Listing Status
Chinook Salmon	Sacramento River Winter-run	Endangered
	Central Valley Spring-run	Threatened
	Central Valley Fall and Late Fall-run	Candidate/ Not Warranted
	California Coastal	Threatened
Steelhead	Central California Coast	Threatened
	Central Valley	Threatened
	Northern California	Threatened
	South-Central California Coast	Threatened
Coho	Central California Coast	Threatened
	Southern Oregon/Northern California	Threatened
Chum Salmon	Pacific Coast	Not Warranted

Northern Coastal California Sites With Management Potential

Sand Island, Humboldt Bay

Site Description

Sand Island is a small relatively flat, dredge spoil island in the Arcata north arm of Humboldt Bay. This island is owned by the Humboldt Harbor District or private landowners. This colony had over 100 nests in 1966 (Shuford and Craig 2002). From the 1970s to 1990s, the only reported tern nesting in Humboldt Bay was 20 pairs in 1979 (Shuford and Craig 2002). In 2001 and 2002, adult terns have been observed on and near Sand Island, including five flightless chicks (August 2002), confirming nesting activity (M. Colwell pers. comm.).

Prey Base

A variety of fish species occur in Humboldt Bay including Pacific herring, northern anchovy, chinook and coho salmon, steelhead, surf smelt, and shiner perch (Barnhart et al. 1992). No diet studies have been conducted to document specific species of tern prey.

Management Issues

It is unclear why Caspian terns abandoned Sand Island in the 1970s. Recent adult presence and nesting activity suggest that terns are re-colonizing the island. Habitat enhancement may be helpful in encouraging re-establishment of the colony.

Opportunities and Needs

Given Caspian terns have again nested on this historic nesting island in recent years, potential to enhance the site for terns is good. Some minimal vegetation removal may be necessary to enlarge the current nesting area. Ownership of the island needs to be confirmed to ensure cooperation from the landowner before any development of management plans. Development of management plans and associated environmental review documents of any proposed project would involve key agencies such as the Harbor District, CDFG, USFWS, and the Corps.

Knight Island, San Pablo Bay

Site Description

Knight Island is a former salt pond along the Napa River currently owned by California Department of Fish and Game (CDFG). A row of former ditch spoils create islands when the pond is flooded and high spots are left exposed. Most of the islands are bare with little vegetation. Other nesting colonial waterbirds include double-crested cormorants and Forster's terns (*S. forsteri*). A dike breach occurred in August 2002, connecting the pond to San Francisco Bay. Caspian tern chicks



Nesting Caspian terns (center of photo) on Knight Is.

had fledged by this point, but it is unclear whether the islands will be exposed for nesting habitat in the future.

Prey Base

Gill (1976) collected 605 fish specimens from a Caspian tern colony in South San Francisco Bay in 1971. Primary species included jacksmelt (33%), shiner perch (16%), and staghorn sculpin (16%). Less than 1% of the fish collected were salmonids. Other fish that occur in the bay and are potential prey include Pacific herring, sculpin, stickleback, northern anchovy, jacksmelt, and salmonids (e.g., chinook, steelhead, Goals Project 2000).

Management Issues

The major management issue is future site availability. CDFG owns numerous historic salt ponds in this area and plans to release a draft management plan and environmental impact statement in winter 2002/2003 to assess and determine future management of these sites. Management options for these sites include tidal restoration or maintenance of impoundments with open water habitat. Knight Island was proposed as one of the first sites to be returned to tidal influence. As water is difficult to control at this site, CDFG was considering breaching dikes to return tidal influence with no further management. However, in late summer 2002, the dike at Knight Island was breached illegally and has not been repaired by CDFG. This late-season event, most likely did not affect the nesting terns; it is unclear, however, whether the dike will be repaired and if these nesting islands will be available in 2003. Potentially new and more stable islands can be constructed in open water impoundments near this site. These impoundments are also owned and managed by CDFG. CDFG has better water management capabilities at these nearby sites and thus may be able to ensure that tern nesting islands remain above high water levels.

Mammalian predators become an issue when low water levels connect the islands to the external dike. There is likely minimal potential conflict with tern predation on listed salmonid species because of the high availability of a variety of marine fish in the bay (T. Huffman pers. comm.).

Opportunities and Needs

There is an immediate need for a stable nesting site because of the dike breach in August 2002. Perhaps the dike can be breached at a second location, creating an island between the two breach locations. Larger, stable islands can be developed in some salt ponds northwest of this site. Island construction would require heavy equipment. Development of management plans and associated environmental review documents of any proposed project would involve key agencies such as CDFG, USFWS, and the Corps.

Cullinan Ranch, a unit of San Pablo Bay NWR, is immediately south of Knight Island. The Refuge is considering flooding this site for tidal restoration. Since this is a large site, it would likely require the construction of several islands to impede wave erosion of external dikes. Such islands could also provide nesting habitat for Caspian terns. Discussions with Refuge staff will be necessary. Predator control might be necessary if any of these islands are located near the external dikes or if water levels are shallow enough to allow access by mammalian predators.

Brooks Island, Central San Francisco Bay

Site Description

Brooks Island is a 32 ha (80 a) island in the central portion of San Francisco Bay. The island is owned by East Bay Parks and is managed as a Regional Preserve for protection of its natural resources. Caspian terns nest there on a flat sandy spit [0.1 ha (.25 a)] on the northwestern end of the island. In 2002, 825 pairs breed in this area. Vegetation in this area is dominated by an introduced ice plant and low forbs.



Caspian tern nesting area on sandy spit, Brooks Island.

Prey Base

Potential prey resources are similar to those described above for Knight Island.

Management Issues

One management issue on Brooks Island is the availability of tern nesting habitat that does not flood during extremely high spring tides. Caspian terns nest along the shoreline in open, sandy areas close to the water. Some of the nests closest to the water line have been washed out during such tides (S. Bobzien pers. comm.). In 2001, island caretakers cleared out some of the vegetation adjacent to the tern nesting site and above the reach of the highest tides. In 2002, terns successfully used this new area. Additional removal of non-native vegetation would likely further enhance tern nesting habitat on this island.

Another management issue is human disturbance at both the colony site and immediately offshore. Sea kayakers often land on the spit and walk through the tern and gull colonies. There is a legal boat landing area at the end of the spit but the adjacent tern and gull nesting area is closed to public access. This area is signed and separated with a low wooden post fence. Caretakers stationed at the island enforce the closure but some disturbance still occurs. Disturbance may also occur when kayakers or boaters come close to shore and flush nesting terns. A protected buffer limiting human activities around the spit may help eliminate this disturbance.

Other disturbance to the colony comes from annual dredging conducted by the Corps in the navigation channel near the island. This activity is extremely loud and occurs for several days (day and night). Local biologists are concerned that this activity, conducted during the breeding season, may have a negative effect on nesting terns. The noise could potentially prevent communication between adults and chicks, especially older chicks that wander into shallow water at night (S. Bobzien pers. comm.).

Predation is another management issue at this site. Rats have been documented on the island and also occur in high numbers on a rock jetty located offshore near the nesting area. Although there is no direct evidence of rat predation on eggs and chicks, it could occur and reduce tern nesting success. In addition, feral animals occur on the upper island and could potentially move down

onto the spit. Effects could include direct predation on adults, chicks, or eggs but also colony disturbance leading to exposure of tern eggs or chicks to gull predation or the elements. There is minimal potential conflict from predation on listed salmonid species because of the high availability of a variety of marine forage fish in San Francisco Bay.

Opportunities and Needs

Potential management opportunities at this site include vegetation removal to increase the size of the current nesting site, reduction of human disturbance, and predator control. Discussions will be needed with East Bay Parks, which owns and manages the island. The quality and size of Caspian tern nesting habitat can be enhanced by removing vegetation above the current nesting site. This can all be done manually. The area would likely need to be repeatedly cleared in the future to ensure long-term availability of the nesting area. Additional signs and educational efforts can help reduce human disturbance in the nesting colonies. Information at the nearby marina as well as outreach efforts with kayak organizations (including commercial guides) would help educate the public on the sensitivity of nesting terns. Discussions should be initiated with the Corps to time their dredging efforts outside of the breeding season to eliminate any potential disturbance. Rat and other feral animal control efforts should be initiated to eliminate potential mammalian predation. Development of management plans and associated environmental review documents of any proposed project would involve key agencies such as East Bay Parks, USFWS, and the Corps. Any proposed project would require Endangered Species Act compliance.

Proposed Alameda NWR, Central San Francisco Bay

Two sites at the former Alameda Naval Air Station are discussed together below because their physical features, prey resources, and management issues are similar.

Site Description

This site is located on the former Alameda Naval Air Station, which is currently undergoing base closure and cleanup. USFWS currently manages for California least terns and brown pelicans on the refuge, but transfer of ownership to the Service has not occurred. Two potential locations for nesting Caspian terns are adjacent to a former runway and the bay shoreline. The West wetland, a historic nesting site, is on a former landfill west of the runway, where potential contaminant issues are unresolved. The site contains a wetland with a peninsula that is heavily vegetated with grasses and forbs. Caspian terns nested on the tip of this peninsula from 1985 - 1999, with a peak of 1,020 nests in 1991 (Shuford and Craig 2002).



Caspian terns nested historically on the tip of this peninsula in the West wetland



Runway wetland

The second site, Runway wetland, is adjacent to a wetland south of the runway. This wetland is created by seasonal rains and some tidal waters that flow in through a one-way tide gate. An upland area adjacent to the wetland can be enhanced to provide habitat for nesting terns. It is currently covered with dense low grasses and scattered shrubs.

Prey Base

Potential prey resources are similar to those described above for Knight Island.

Management Issues

The primary management issue at these two locations is vegetation removal to provide the open nesting habitat preferred by Caspian terns. Vegetation encroachment on the historic nesting site is believed to be the reason for the colony abandonment in 1999. Both of these sites are currently heavily vegetated with grasses and forbs, which should be removed to expose bare ground. Sand or rocky substrate may need to be added to prolong the period before the grasses recolonize. Repeated vegetation removal in the future would likely be necessary.

Mammalian predators may also be an issue at these sites. Intensive predator control is conducted at a California least tern colony in the center of the runway. In addition, a chain-link fence separates the refuge area from the rest of the Navy base. These control efforts will help reduce mammalian predators in the area but some might still enter a future Caspian tern colony. There is minimal potential conflict with tern predation on listed salmonid species because of the high availability of a variety of marine fish in the bay.

Contaminant concerns are high at these sites. In addition to the potential contaminants in the bay, stormwater runoff from the runway which flows directly into the Runway wetland, may also contain potential contaminants. The West wetland is a former landfill site and contains several contaminants that need to be removed (U.S. Fish and Wildlife Service 2000). Discussions are ongoing between the U.S. Navy and Fish and Wildlife Service to ensure that all contaminant issues on the site are resolved.

Opportunities and Needs

Although habitat can be easily enhanced to attract terns back to this site, the ability to actively manage this site is limited until ownership is transferred to USFWS. The transfer date is unknown at this point and thus, it is unclear when the site would be available for nesting Caspian terns. In 2000, Alameda NWR completed a Comprehensive Conservation Plan which identified a goal to “Preserve, maintain and enhance habitat for migratory birds, and protect important foraging, nesting, and roosting habitats from disturbance.” A specific objective under this goal is to “Maintain habitat for at least 300 pairs of nesting Caspian terns on the West Wetland, and restore habitat conditions to increase the colony size to early 1990 levels with a population goal of 1,000 nesting pairs.” Thus, once ownership is transferred and environmental cleanup has been completed, a specific habitat management plan can be developed to meet this objective. Habitat

management activities would include the removal of vegetation involving heavy equipment. Development of management plans and associated environmental review documents of any proposed project would involve key agencies such as CDFG, USFWS, and the Corps.

Salt ponds, South San Francisco Bay

Site Description

Three salt ponds in South San Francisco Bay contain small islands appropriate for nesting Caspian terns. Because their physical features, prey resources, and management issues are similar, these sites are discussed together.



Caspian tern nesting island in Pond 10.

Pond 10: Pond 10 in the Baumberg tract just south of the San Mateo Bridge, contains two very small islands, less than 0.005 ha (<0.01 a) in total area. This pond is currently an active salt pond, but ownership will be transferred to CDFG within the next year. The islands are relatively flat composed of silt and sand, and bare except for small clusters of pickleweed. A colony of about 80 pairs (total on both islands) of Caspian terns nested here in 2002.

Pond A7: Pond A7 is currently an active salt pond, but ownership will be transferred to USFWS and the pond managed as part of the San Francisco Bay NWR Complex. This pond is located at the very southern end of San Francisco Bay near Alviso. Caspian terns nest on all three islands which total <0.02 ha (0.04 a). Each island has a duck blind at its center, but otherwise is bare and relatively flat.



One of three islands in Pond A7



Potential nesting island in Pond A16

Pond A16:

This salt pond is also located near Alviso at the very southern end of San Francisco Bay, but is already owned by USFWS as part of the San Francisco Bay NWR Complex. Salt harvest still occurs, but will end in 2003. The islands in this pond were recently created and provide habitat to nesting Forster's terns. Although habitat is suitable, Caspian terns have not nested in this pond since the islands were created in 1997. Both islands are long and narrow, relatively flat, and bare.

Prey Base

Potential prey resources are similar to those described above for Knight Island.

Management Issues

The major management issue at these sites is availability of protected nesting habitat. Both CDFG and USFWS are considering a number of long-term management options for these ponds after salt harvesting has been terminated. A total of 15,500 acres of ponds will be under management control of either CDFG or USFWS by 2003. Management options focus on tidal restoration but also include maintaining impoundments with open water habitat and islands. If tidal restoration is selected as the management option for the three ponds discussed above, these islands would be lost and no longer available for Caspian terns. Conversely, if open water impoundments are selected for the three ponds discussed above, larger and more stable islands can be created, which would provide more habitat for Caspian terns. These management scenarios will most likely be possible at any of the remaining salt ponds that will be under CDFG or USFWS management. Thus, there is great management potential for Caspian terns in south San Francisco Bay in the future. However, as with the Alameda and Knight Island sites, habitat management plans are currently being developed. Hence, the management options selected and the time frame for their implementation are unknown.

Mammalian predators can access the islands when water levels become low. However, predators are controlled on these lands currently and it is likely to continue in the future. In addition, the management regime of individual salt ponds could include retaining sufficient water levels necessary to eliminate predator access. Based on past data collected by Gill (see above), there would most likely be minimal conflict with tern predation on listed salmonid species because of the high availability of a variety of marine fish in the Bay.

Opportunities and Needs

The potential to enhance nesting habitat for Caspian terns at these three ponds are good if these sites remain as impoundments. Larger and more stable islands can be developed to provide more nesting habitat. Discussions with CDFG and USFWS are necessary to ensure that management plans they are developing for these and other south San Francisco Bay ponds will include creation or enhancement of Caspian tern nesting habitat. Island construction would require heavy equipment. Predator control might be necessary if any of these islands are located near the external dikes or if water levels are shallow enough to allow access by mammalian predators. Development of management plans and associated environmental review documents of any proposed project would involve key agencies such as CDFG, USFWS, and the Corps.

Elkhorn Slough, Monterey Bay

Site description

Caspian terns are currently nesting on islands created from dredge materials as part of a wetland restoration project. The islands are flat-topped with gradual and steep sides and have salt marsh vegetation and bare ground. The islands are slowly eroding and are prone to vegetation

encroachment. Caspian terns formerly nested on an eroded levee island or peninsula in a set of abandoned salt ponds on the north side of Elkhorn Slough. In most years from 1992 - 2001, terns nested on Boomerang Island and in 2002 also on a smaller adjacent island. From 1997-2002, the size of the colony ranged from 0 - 80 pairs (~50 pairs in 2002; Shuford and Craig 2002). These islands are within the Elkhorn Slough National Estuarine Research Reserve, which is owned and managed by CDFG in partnership with the National Oceanic and Atmospheric Administration.



Caspian Tern Colony at Elkhorn Slough

Prey Base

Primary prey include shiner surfperch, northern anchovy, silversides, crayfish, and Pacific staghorn scuplin (Parkin 1998). Salmonids were not found to be prey items of Caspian terns. Terns forage mainly in Elkhorn Slough, Moss Landing Harbor, and along a 20 km (12 mi) stretch of near shore coastal waters between the Salinas and Pajaro rivers with Elkhorn slough at its mid-point (Parkin 1998).

Management Issues

The primary management issue at this site is providing stable, unvegetated nesting habitat. The current nesting islands are slowly eroding and have salt marsh vegetation that will exclude nesting terns if not suppressed. Vegetation removal or control would be necessary on an annual basis. Predation by mammals is also an issue as the colony failed in 1996 from predator activities. Poor reproductive success in 1995 was attributed to contaminants resuspended during flooding and concentrated in tern eggs through their prey.

Opportunities and Needs

The potential to enhance this site for Caspian terns by providing stable and increased habitat is good. Decoys and recordings would help to attract terns to new locations. Predator control may be necessary if any of the nesting locations allow access by mammalian predators. Development of management plans and associated environmental review documents of any proposed project would involve key agencies such as CDFG, USFWS, and the Corps. Any proposed project would require Endangered Species Act compliance.

Northern Coastal California Sites Without Management Potential

Bair Island: Bair Island, a south bay site in San Mateo County owned by both the San Francisco NWR Complex (Refuge) and CDFG, has been inactive since 1994; the Refuge manages CDFG lands as part of the Refuge. Tern numbers there reached a peak of 850 pairs in 1988 (Shuford and Craig 2002). Bair Island was abandoned because of high red fox predation, encroaching vegetation, and erosion of levees that lead to tidal inundation of the colony site (Shuford and Craig 2002). The Refuge in cooperation with CDFG is developing a plan that would restore 567

ha (1,400 a) of former salt ponds to tidal influence; the plan and associated EIS will be released in winter 2002/2003 (J. Buffa pers. comm.). Tidal restoration at Bair Island would permanently eliminate Caspian tern nesting habitat.

Several other sites throughout San Francisco Bay have been used by nesting Caspian terns in the past. Terns either abandoned sites or moved among sites because of annual changes in habitat availability or heavy predation. Some sites, such as Coyote Hills, are no longer available or are repeatedly disturbed by routine maintenance of salt pond levees. Thus, these sites do not provide stable, quality nesting habitat for Caspian terns.

Salinas River: Salinas River is near Elkhorn Slough in Monterey Bay. Terns nesting at Salinas River has been sporadic, and the colony is heavily dependent on predator control implemented to protect nearby western snowy plover nests. Terns have used this site irregularly since 1983, and colony size varies greatly among years. In 2002, about 93 pairs of terns nested in the Salinas River NWR on a flat-topped, low-lying hillock by the shore of a brackish pond adjacent to the foredune of the beach and less than 1 km from the mouth of the Salinas River. The presence of Caspian terns at this site has possible negative as well as positive effects on nesting western snowy plovers. Caspian terns attract flocks of roosting gulls, which may trample western snowy plover nests. In 2002, plover nests in the vicinity of the tern colony were destroyed or abandoned. In addition, terns may also exclude snowy plovers from prime chick-rearing areas on the shoreline of the pond. On the other hand, the terns appear to deter avian predators, such as the northern harrier (*Circus cyaneus*), from entering the area and preying on western snowy plovers. Although not limited by available habitat, this site's potential for supporting a large Caspian tern colony is compromised by complications with compatible management for threatened snowy plovers. If habitat enhancement is implemented nearby at Elkhorn Slough, that site could serve as the main nesting area of Caspian terns at Monterey Bay.

SOUTHERN COASTAL CALIFORNIA

For the purposes of this report, the Southern Coastal California region consists of the area from Los Angeles south to San Diego. The heavily urbanized corridors around the waterfronts, bays, and marsh systems in this region have been converted to or are surrounded by residential and commercial developments. Only small and widely scattered fragments of wildlife habitat remain, most of which are human-created or altered. The Port of Los Angeles developed Terminal Island to accommodate increased traffic by cargo container ships and was required to create a mitigation site for California least terns. This site is now also used by several other species of colonial nesting birds, including Caspian terns. In San Diego, levees surrounding the salt ponds of

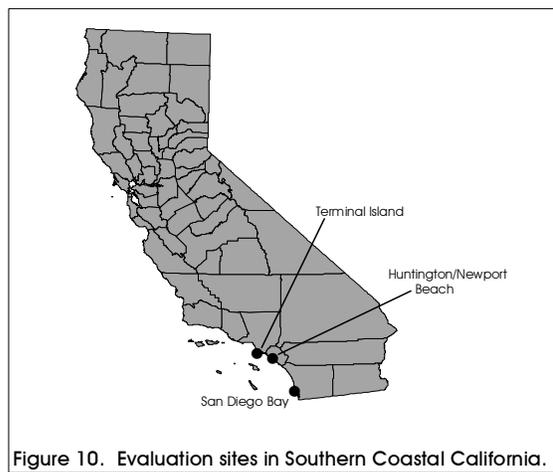


Figure 10. Evaluation sites in Southern Coastal California.

the South San Diego Bay Saltworks form nesting habitat for terns. A site at Bolsa Chica Ecological Reserve currently used by Caspian terns was specifically developed for California least terns. The reserve is an impounded tidal wetland that is surrounded by urban development and a beach with high recreational use.

In these areas, no salmonids or listed fish are present as potential prey for terns. The top fish species consumed by Caspian terns on the southern California coast are northern anchovy, Pacific sardine, and topsmelt (*Atherinops affinis*, Horn and Dahdul 1999).

The main management issue for Southern Coastal California sites is the lack of suitable and protected nesting habitat. In San Diego and Los Angeles, continued urban growth is shrinking the existing habitat to small scattered parcels. In particular, conflicts with the smaller California least terns are of particular concern from CDFG (CDFG in litt.).

Southern Coastal California Sites With Management Potential

Bolsa Chica Ecological Reserve, Huntington Beach

Site Description

Bolsa Chica Ecological Reserve is just north of Huntington Beach, California. The Pacific Coast Highway and Bolsa Chica State Beach separate the reserve from the Pacific Ocean. The reserve, owned by the California State Lands Commission but managed by CDFG, is tidally influenced from the north at Seal Beach. Two human-created islands, each about 1.7 ha (4.2 a), are within the long impoundment next to the Pacific Coast Highway. The north island generally contains most of the colonial nesting birds. These stable islands are comprised of sand and rise 0.3-1.2 m (1- 4 ft) above water. Most vegetation is removed by volunteers before each nesting season. The islands are protected from public intrusion year-round by fencing. Much of the area has been developed as pump wells for petroleum production. Trucks occasionally pass near the islands while making the rounds to each of the pump stations.



North Island, Bolsa Chica Ecological Reserve

In 2002, Caspian terns established 192 nests on the north island. Other colonial nesting species on the islands included Forster's terns (~235 pairs), elegant terns (*S. elegans*; ~100 pairs), black skimmers (*Rynchops niger*; ~386 pairs), and royal terns (*S. maxima*; occasional pair[s]). Before Terminal Island was created, ~18 km (11 mi) to the northwest, large numbers of elegant terns nested on these islands. In 2002, elegant terns (~4,000-5,000 pairs) nested at nearby Terminal Island.

Prey Base

Caspian terns forage in inshore waters of the ocean, Seal Beach estuary, and the ecological reserve. Northern anchovies, Pacific sardine, and topsmelt, comprise 75% of the prey species of Caspian terns (Horn and Dahdul 1999). Horn et al. (1996) reported that Caspian terns spent 69 % of their time foraging in the marine environment and 20% in bay-estuarine habitats. No protected fish species occur in the area.

Management Issues

Bolsa Chica Ecological Reserve has the potential to provide habitat for birds that will eventually be displaced at Terminal Island (see below). Currently wetland restoration plans are being developed for the reserve. A current proposal calls for breaching a tidal access point between the south end of the ecological reserve and the ocean so several tidally influenced impoundments can be established near the south island. It is possible that the creation of islands that can serve as nesting habitat for Caspian terns can be incorporated into restoration plans.

Competition between several tern species for the current nesting habitat is increasing. California least terns, the smallest nesting terns in the area, are at a disadvantage and are easily pushed aside by the larger Caspian and elegant terns. Thus, enlarging the existing Caspian tern colony could potentially impact California least terns. In addition, management activities conducted for the protection of listed least terns sometimes negatively affect Caspian terns. For example, on Terminal Island, light hazing of the Caspian terns has been done to allow California least terns to establish nesting sites before the larger terns. In addition, other listed species occur in the area; western snowy plovers nest in shallow impoundments to the east, and the state endangered Belding's savannah sparrow (*Passerculus sandwichensis beldingi*) is fairly common in and around the vegetation on the dikes and islands. It is unclear how increasing nesting opportunities for Caspian terns in this area will affect these species.

Opportunities and Needs

Through the combined efforts of USFWS, NOAA Fisheries, the Corps, Environmental Protection Agency, California State Lands Commission, California Coastal Conservancy, CDFG, and California Resources Agency, about 356 ha (880 a) of the Bolsa Chica lowlands in Orange County were acquired in 1997. The land is now owned by the State Lands Commission. The agencies listed above are now proceeding with the planning and environmental review necessary to design and obtain regulatory permits for the Bolsa Chica Wetlands Restoration Project. The purpose of the project is to provide for the most ecologically appropriate restoration of the lowland wetlands and will most likely include restoring tidal influence to the reserve. Development of management plans and associated environmental review documents of any proposed project would involve key agencies such as State Lands Commission, State Coastal Conservancy, CDFG, USFWS, and the Corps.

Recently, the State Lands Commission doubled the size of the reserve by acquiring the land between the ecological reserve and the bluffs to the east. This area contains a large number of impoundments. To this date, no plans have been developed for this area, but the potential exists for the creation of multiple islands for colonial nesting birds. Heavy equipment would be needed to create the islands. Discussions would need to be initiated with the State Lands Commission

and CDFG to request their assistance in developing tern nesting islands. There are also several private conservation groups active in conservation issues at Bolsa Chica (Bolsa Chica Land Trust, Amigos de Bolsa Chica, Bolsa Chica Conservancy).

Upper Newport Bay Ecological Reserve, Newport Beach

Site Description

Upper Newport Bay Ecological Reserve (owned by CDFG) has two islands, made specifically for California least terns, which are just downstream from the Jamboree Road bridge over San Diego Creek and about 7 km (4.4 mi) from the ocean. The islands, created about 15 years ago, are vegetated mostly around the edges with some shrubs, forbs and grasses. The dredge material is comprised of silt with sand on top. The islands are stable but silt has accumulated over the years around and downstream of the islands. At low tide, the islands are nearly connected to the mainland. Although difficult for humans to cross, this tidal flat may encourage predators to reach the islands.



Upper Newport Bay islands during out-going tide

The islands are approximately 1.2-1.6 ha (3-4 a) in size and currently provide nesting habitat for California least terns (~25 pairs), Forster's terns (colony size unknown) and black skimmers (300-350 pairs). The surrounding tidal flats and salt marsh are managed for the endangered light-footed clapper rail (*Rallus longirostris levipes*). No Caspian terns have nested on the islands though they forage and roost in the vicinity.

Prey Base

If a colony were established, Caspian terns would likely forage mainly along the Newport Bay estuary and the adjacent inshore ocean. Anchovies, sardines, and topsmelt would likely be the top prey species for Caspian terns. No listed fish species are known to occur in the estuary.

Management Issues

The primary management issue at this site is siltation around the island. If siltation continues, connection to the mainland will be more extensive and may become permanent, allowing access by mammalian predators. Dredging can be conducted and the material used to enlarge the islands. In addition, although the islands are protected from human disturbance, occasional kayakers may approach the islands.

Similar issues associated with potential conflicts with listed species occur for this site as well (see Bolsa Chica section above).

Opportunities and Needs

It is uncertain why Caspian terns have not nested at this site because the habitat on these islands is similar to that at Bolsa Chica. The area around the Upper Newport Bay islands has increasingly silted in. The Corps plans to enhance the islands beginning in 2004 (L. Smith pers. comm.). To date, the Corps has completed an Environmental Impact Statement and signed a Record of Decision. They propose to move the north island downstream ~ 0.4-0.8 km (0.2 -0.5 mi) and to dredge a deep water channel around the perimeter of the south island. Part of the project is to create a silt catch-basin near the Jamboree Road bridge. Plans do not call for enlarging the islands, but dredged material could be used to augment habitat for colonial nesting birds. A sandy layer would be necessary to enhance the surface of newly deposited dredged spoils to ensure that eggs or chicks do not become entrapped in the silt and die. Since Caspian terns have not nested in this area, decoys and recordings would assist in attracting terns to this site. Development of management plans and associated environmental review documents of any proposed project would involve key agencies such as CDFG, USFWS, and the Corps. Any proposed project would require Endangered Species Act compliance.

Southern Coastal California Sites Without Management Potential

Terminal Island: Terminal Island, owned by the Port of Los Angeles, is ~18-19 km (11 mi) from Bolsa Chica Ecological Reserve. The Terminal Island shipyard is a newly constructed container shipping terminal. Ongoing construction will be completed within a year. As part of a mitigation settlement for wetland fill and loss of wildlife habitat, the Port of Los Angeles has set aside 6 ha (15 a) for nesting terns, mainly the threatened California least tern. In 2001, after the fill material was in place but before construction began, large numbers of elegant (4,000-5,000 pairs), Caspian (~160 pairs), and California least terns (~300 pairs) moved onto 80+ ha (200+ a) of flat sandy habitat adjacent to the water. A few pairs of royal terns and black skimmers also nest on Terminal island. Since most construction was completed, the remaining suitable habitat is confined to 9 ha (23 a) plus several acres of mounded material used by a few pairs of least terns. This area will be further reduced when 3 ha (8 a) adjacent to the mitigation site are developed. Management options will become increasingly limited on this site as acreage is reduced and competition between species increases.

San Diego Bay NWR (Saltworks): South San Diego Bay Saltworks, part of the San Diego Bay NWR Comple, is the only site in the San Diego area that has nesting Caspian terns. Of the saltworks' total area of 400 ha (1,080 a), about 4 ha (10 a) of levees are available for nesting habitat (B. Collins, pers. comm.). Caspian terns share these levees with Forster's terns, gull-billed terns (*S. nilotica*), elegant terns, California least terns, royal terns, black skimmers, and western snowy plovers. These colonial nesting birds do not occupy all available nesting habitat on salt pond levees. Because of the relatively small nesting area and ease of access for mammalian predators, coyotes and feral dogs (*C. familiaris*) have caused considerable damage to the nesting colonies. The Refuge is currently developing a Comprehensive Conservation Plan, which includes management alternatives for these salt ponds. Management options include varying levels of tidal restoration, potentially eliminating current tern nesting habitat. However,

plans also include creating new islands within remaining impoundments to provide habitat to colonial nesting waterbirds, including Caspian terns. Thus, the amount of available nesting habitat in San Diego will likely remain similar to what is currently available, thus there is no management potential for relocating Caspian terns. Efforts should be made, however, to protect and manage the habitat to provide for Caspian terns.

NORTHEASTERN INTERIOR CALIFORNIA

Caspian terns currently breed in the interior of California primarily in the Modoc Plateau and Great Basin Desert of the northeastern portion of the state, in the Tulare Basin of the southern San Joaquin Valley, and at the Salton Sea in the Colorado Desert. For the purposes of this report, the interior region of California has been divided up into three regions: Northeastern Interior, Tulare Basin, and Southern Interior. In northeastern California, colonies occur on islands or, rarely, peninsulas, in large water bodies of terminal lakes and associated wetlands and at reservoirs. Surrounding habitats are typically shrub-steppe, pinon-juniper woodland, or irrigated agricultural fields.

There are six colonies that are active in most years: Meiss Lake at Butte Valley Wildlife Area, Siskiyou County; Clear Lake National Wildlife Refuge, Goose Lake, and Big Sage Reservoir, Modoc County; the Dakin Unit of Honey Lake Wildlife Area, Lassen County; and Mono Lake, Mono County. Elevations at these sites range from about 1220-1950 m (4000-6400 ft). Meiss, Goose, Honey, and Mono lakes are in terminal drainage basins. Clear Lake formerly flowed unimpeded via the Lost River into the terminal basin of Tule Lake but now is dammed to create an agricultural storage reservoir. Big Sage Reservoir also was created to store irrigation water. Potential prey of Caspian terns varies considerably among these sites, though tui chub is among the most widespread fish species in this region.

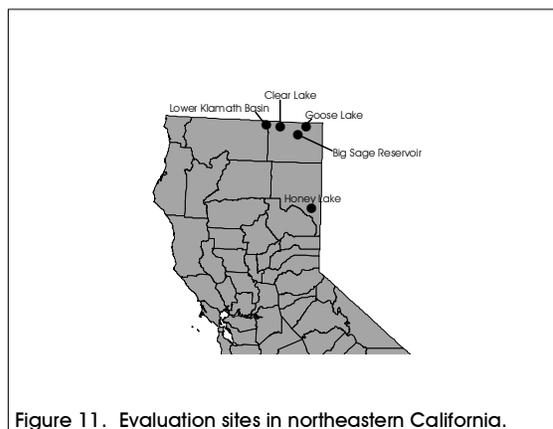


Figure 11. Evaluation sites in northeastern California.

The climate in this region is generally arid, and all of these sites are fed mainly from snowmelt and rainfall from nearby mountains. Water levels at these lakes and reservoirs fluctuate between extremes of drought and flood. During extreme drought all of these sites except Mono Lake can completely or nearly dried up and connect nesting islands to the mainland. Competition for water with nearby agricultural needs may increase the frequency of such events. Conversely, the storage of water for agricultural use has increased the availability of nesting islands at Clear Lake and Big Sage Reservoir. Except during drought years, terns at most sites do not appear to be limited by the availability of suitable nesting habitat. Goose Lake has the least stable nesting habitat, as the very low-lying islands along the southeast shore are exposed or inundated by relatively small changes in the level of the shallow waters at this end of the lake. It is more likely that terns are limited by the availability of suitable prey. Despite abundant nesting habitat,

terns at hypersaline Mono Lake (devoid of fish) must fly at least 15-20 km (9-12 mi) to forage at freshwater reservoirs. The waters at all the other sites are murky, which may reduce foraging success of the terns, and alternative foraging sites are usually distant from the nesting colonies.

Formerly, the Upper Klamath Basin of Oregon and California hosted a vast complex of wetlands and lakes, which have been greatly reduced by reclamation for agriculture. Historic accounts reported nesting by Caspian terns in the Oregon portion of Lower Klamath Lake and in Tule Lake, California. Before 1900, Lower Klamath Lake consisted of about 22,267 ha of marsh and 12,146 ha of open water (Akins 1970). Draining greatly reduced the size of the wetlands, and a portion of the area was protected in 1908 as Lower Klamath NWR, most of which is in California. Tule Lake was formerly a vast freshwater terminal lake in the California portion of the Upper Klamath Basin. Before 1900, this lake fluctuated in size from about 22,267 to 44,534 ha between extremes of dry and wet cycles. Draining greatly reduced the size of the wetlands, and a portion of the area was protected in 1928 as Tule Lake NWR.

Northeastern Interior California Sites With Management Potential

Lower Klamath National Wildlife Refuge

Site Description

Currently, Lower Klamath NWR has 8907 ha (22,010 a) of wetlands; 4858 to 6478 ha (12,004 - 16,007 a) are seasonally flooded and 2024 to 3644 ha (5,000 - 9,004 a) are permanently flooded marshes (USBR 1998). Since the early to mid-1980s, seasonal wetlands in summer have been increased by about 800 ha (1,977a;10-20%), while the extent of farm fields on the refuge has been reduced from about 3,200 to 1,600 ha (7,907 - 3,953 a, D. Mauser pers. comm.). Managing for early successional marshes is done by rotating fields between farming and marshes. From at least 1955-1976, about 15-30 pairs of Caspian terns nested with pelicans and cormorants on tule-mat islands at this refuge.



Aerial view of Lower Klamath NWR

Prey Base

The main species of fish at Lower Klamath NWR likely to be prey of Caspian terns are flathead minnow (most numerous), tui chub, and blue chub (D. Mauser pers. comm.).

Management Issues

Changing water priorities may limit potential foraging and nesting habitat in the area, particularly in summer and fall (D. Mauser pers. comm.). A federal Solicitor's Opinion in 1995 ruled that the Klamath Project's priorities are now endangered species (lakes and rivers), tribal trust (lakes and rivers), agriculture, and refuges. Because of a reduction in water availability

(>50% of total water previously available now allocated to Endangered Species Act compliance, Apr-Sep) and a low priority for remaining water, severe impacts are predicted for Lower Klamath NWR, particularly in summer and fall (USBR 1998, D. Mauser pers. comm.). Water levels at Sheepy Lake, an important site for colonial nesting waterbirds, need to be managed within a narrow range to avoid flooding the nesting islands or connecting them to the mainland. It may be difficult to add to the tule-mat islands currently used by colonial nesting birds at Sheepy Lake. Any alterations to these islands, including any addition of fill material, should be carefully considered to avoid reducing their suitability for colonial nesters, particularly the American white pelican, which is a California Bird Species of Special Concern.

Opportunities and Needs

Potential nesting habitat for Caspian terns could be created on some of the permanent wetland units of the refuge. The site with the highest potential is Sheepy Lake, which currently supports a mixed colony of American white pelicans, double-crested cormorants, and ring-billed and California gulls on remote tule-mat islands. Development of management plans and associated environmental review documents of any proposed project would involve Klamath Basin NWR and key agencies such as CDFG, USFWS, and the Corps. Any proposed project would require Endangered Species Act compliance.

Tule Lake National Wildlife Refuge

Site Description

Currently, wetlands in Tule Lake NWR are confined mainly to two sumps on the refuge maintained by return flows from agricultural fields. The Upper Sump (1-A) and Lower Sump (1-B) combined total about 5,263 ha. Historically, Caspian terns apparently nested on natural islands of Tule Lake. From at least 1952-1962, though, 4-80 pairs nested on islands created in the refuge sumps in the 1930s, which subsequently were greatly reduced in size by erosion.

Prey Base

The main species of fish in Tule Lake likely to be prey of Caspian terns are flathead minnow, tui chub, and blue chub (D. Mauser pers. comm.). The endangered Lost River and shortnose suckers are present in Tule Lake, but size classes suitable for terns may not be available because the suckers do not reproduce in Tule Lake.

Management Issues

Unlike adjacent Lower Klamath NWR, Tule Lake NWR has a more dependable water supply because of the presence of the endangered Lost River and shortnose suckers. Hence, the issue of changing water priorities in the Klamath Basin, described above, is not likely to have as great an effect on Tule Lake as on Lower Klamath.

Opportunities and Needs

Restoration potential is good on the Tule Lake sumps because these large water bodies with relatively deep water would enable the creation of isolated islands. The presence of a colony of nesting cormorants on the Lower Sump might provide a catalyst for other colonial waterbirds,

including Caspian terns, to colonize any new islands. Plans to revitalize the Tule Lake wetlands may reduce the amount of open water but at the same time present management opportunities that may benefit Caspian terns and other colonial waterbirds (D. Mauser pers. comm.). Creation of nesting islands in the Tule Lake sumps would require heavy equipment. Development of management plans and associated environmental review documents of any proposed project would involve Klamath Basin NWR and key agencies such as CDFG, USFWS, and the Corps. Any proposed project would require Endangered Species Act compliance.

Northeastern Interior California Sites Without Management Potential

Meiss Lake, Butte Valley Wildlife Area: A shallow terminal lake, Meiss Lake was reduced in size by diking in the 1940s, became part of Butte Valley Wildlife Area in 1981. Caspian terns nest here on islands with other colonial breeders, primarily ring-billed and California gulls. Nesting islands typically are plentiful, and terns are unable to nest here only during severe droughts, when the lake shrinks or disappears, connecting islands to the mainland. The existence of only one species of fish (tui chub) in Meiss Lake, the murky waters of the lake, and the distance to alternative foraging areas all suggest that the terns may be limited by the availability of suitable prey. Further circumstantial evidence of prey limitation is the abundance of nesting habitat coupled with the small size of the nesting population, which has ranged from about 16 to 50 pairs (Shuford and Craig 2002).

Clear Lake NWR: Clear Lake historically was a natural lake with two distinct lobes: a west lobe of about 4,048 ha of shallow open water and an east lobe of about 2,024 ha of marshlands (Akins 1970). Damming its inflow in 1910 created an open water reservoir, which today covers about 9,623 ha (USBR 1998). The reservoir, incorporated in Clear Lake National Wildlife Refuge in 1911, is the primary source of water for agricultural in the eastern half of the Klamath Basin; water levels are regulated by the U.S. Bureau of Reclamation. The islands occupied vary with lake level, and the terns usually nest in association with other colonial waterbirds, such as ring-billed and California gulls and American white pelicans. Nesting habitat is not limiting to the terns except in very dry years in which irrigation withdrawals lower water levels and connect islands to the mainland. Numbers of breeding terns vary but often range from 200-300 pairs. Foraging may be limited somewhat by the murky water of the reservoir and the distance to additional foraging sites. The most prevalent species of fish in Clear Lake are shortnose sucker, Sacramento perch, blue chub, tui chub, brown bullhead, and Lost River sucker. The most common species in the lake's tributaries and in shallow reservoirs above the lake are tui chub, blue chub, brown bullhead, green sunfish, and speckled dace (M. Buettner pers. comm.).

Juveniles of the endangered Lost River and shortnose suckers are vulnerable to predation because they occupy shallow water along the edge of the lake; they also occur in the tributaries and small reservoirs. Generally little can be done to enhance tern habitat at Clear Lake given wildlife managers do not control water levels and nesting islands are usually available. Biologists, though, have erected electric fences to protect colonial nesters when low water levels have connected islands to the mainland (Klamath Basin NWR files).

Goose Lake: Goose Lake, on the Modoc Plateau, is a large terminal lake straddling the Oregon-California border. Various colonial nesting waterbirds occupy low-lying islands in the southeastern (California) portion of the lake, which vary greatly in size and distribution with relatively small changes in lake level induced by climatic fluctuation. Islands suitable for Caspian terns are unavailable in some years, even when the lake level is relatively high, and then the terns either do not nest or nest on peninsulas. Terns here may form a metapopulation with those at Big Sage Reservoir, about 25 km to the south. Numbers at these sites appear to be inversely correlated, with highest numbers at Goose Lake when suitable nest sites are available, perhaps indicating better foraging conditions there. Caspian terns nest in close association with other colonial waterbirds, particularly ring-billed and California gulls. Nesting may be irregular, but estimates of numbers of nesting terns usually range from about 100-300 pairs when islands are available. As with other sites in the region, foraging may be limited somewhat by the murky water of the lake and the distance to additional foraging sites. Fish present in Goose Lake are Goose Lake tui chub, Goose Lake sucker, Goose Lake lamprey, Goose Lake redband trout, speckled dace, brown trout, and Pit sculpin (P. Chappell pers. comm.). It might be valuable to create more permanent islands farther offshore but this likely would be possible only during a brief window of opportunity in an extended drought and likely would be very expensive.

Big Sage Reservoir: Big Sage Reservoir is a large reservoir on the Modoc Plateau. It was completed in 1921 and its capacity was increased after World War II; it now covers about 2,133 ha (DWR 1988). It is unclear when suitable nesting islands became available or when terns or other colonial waterbirds first occupied them. Caspian terns currently nest here on Bird Island in close association with ring-billed and California gulls. Water levels are regulated to satisfy irrigation needs, but Bird Island is available except during periods of severe drought when it is connected to the mainland. Nesting by Caspian terns is irregular, and estimates have reached a maximum of 75 pairs. Potential fish prey at Big Sage Reservoir are tui chub, channel catfish, largemouth bass, brown bullhead, Sacramento sucker, and black crappie (P. Chappell pers. comm.). That the reservoir's water is very murky and that terns do not always nest when nesting habitat is available suggests that prey availability may limit the size of the Big Sage population. See the comments above regarding the likelihood that nearby Goose Lake is typically preferred for foraging and hence for nesting when islands are available. These factors and the control of reservoir levels by a local irrigation district indicates there is little that can be done to enhance tern habitat at this site.

Honey Lake Wildlife Area: Honey Lake Wildlife Area lies adjacent to Honey Lake, a terminal lake at the western edge of the Great Basin near Susanville. Formerly a dairy ranch, since the early 1940s the area has been a state wildlife area managed by CDFG. Caspian terns nest at the Dakin Unit of the wildlife area. In most years they breed in association with ring-billed and California gulls on islands in Hartson Reservoir, a natural lake separated from saline Honey Lake by sand dunes. When water levels were low in Hartson in 2001 and 2002, the terns nested with the gulls in an adjacent diked pond (5A). In dry years, terns may not nest at either site or may fail when coyotes cross shallow water to reach the colony. Estimates of the number of nesting terns have ranged from about 15-250 pairs. The primary fish species likely to be available to Caspian terns in the Honey Lake vicinity is tui chub, though other benthic feeders, such as speckled dace, mountain sucker, channel catfish, and brown bullhead may be available in shallow or receding waters (P. Chappell pers. comm.). Refuge personnel try to maintain water

levels high enough to preserve isolation of nesting islands, but in drought years this is precluded by the expense of pumping ground water (B. Tatman pers. comm.). Current efforts to ensure full access to water rights may improve the future ability to maintain adequate levels in Hartson Reservoir. Given current limitations to water availability, though, and lack of evidence of a limitation of nesting habitat in most years, there is little opportunity for enhancing tern habitat at this site.

Mono Lake: Mono Lake is another Great Basin breeding site further south near the small town of Lee Vining at the base of the east flank of the Sierra Nevada. The lake lies within the Mono Basin National Forest Scenic Area created in 1984. The lake's islands are owned by either the Forest Service or the state of California. This large hypersaline lake lacks fish, and, hence, terns must fly at least 15-20 km to forage at freshwater reservoirs. Fish (all introduced) that occur in Mono Basin streams and reservoirs are brook trout, cutthroat trout, golden trout, rainbow trout, brown trout, Owens sucker, mosquitofish, threespine stickleback, and, perhaps, goldfish. Only tui chub and brown trout are likely, though, to be important prey of Caspian terns (D. Sada pers. comm.). The few breeding terns (1-15 pairs) nest on the lake's barren islands in association with a colony of California gulls, which has ranged from about 17,500-32,500 pairs. Water diversions beginning in 1941 lowered the lake by 45 vertical feet. A recent decision to restore Mono Lake, though, will allow the lake to rise from the 1994 lake level of 1,943 m (6,374 ft) above sea level to 1,948 m (6,391 ft), a process expected to take about 20 years and to ensure isolation of the lake's islands. Although the terns have shifted nesting islands during the period of declining lake level, they have always had an abundance of potential nesting habitat. The size of the tern colony appears limited by the lack of fish in Mono Lake and the relatively small fish populations in the few reservoirs within easy foraging distance of the nesting islands. Hence, there does not appear to be anything that can be done to enhance tern habitat at Mono Lake.

TULARE BASIN (INTERIOR CALIFORNIA)

All colonies in the Tulare Basin are in artificial habitats of agricultural evaporation ponds, floodwater storage basins, or sewage ponds within a matrix almost totally dominated by agricultural fields. Caspian terns have recently nested intermittently at eight human-created sites in the arid Tulare Basin of the southern San Joaquin Valley. Natural wetlands and lakes are now very rare in this area almost totally dominated by agriculture. Three of the sites are agricultural evaporation basins created in the late 1970s to mid-1980s to dispose of salt-laden drain water from nearby irrigated fields: Westlake North and Westlake South evaporation basins, Kings County, and Tulare Lake Drainage District (TLDD) South Evaporation Basin, Kings and Kern counties. Another site – Westlake Farms mitigation wetland

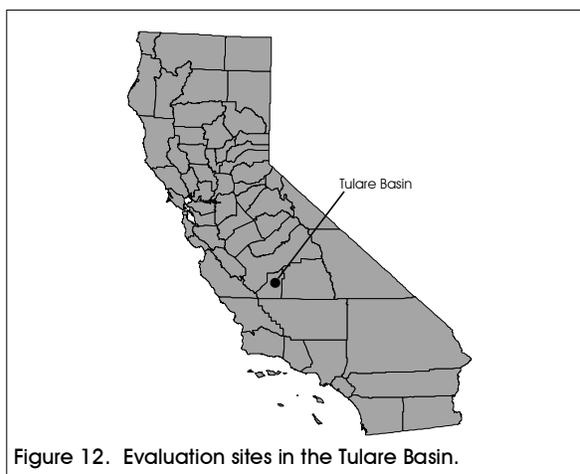


Figure 12. Evaluation sites in the Tulare Basin.

(Section 3) – was created to mitigate for selenium contamination of wildlife using the adjacent evaporation basin (Westlake South). Three additional sites are used as floodwater storage basins where excess waters are held for later use in irrigating fields. The South Wilbur Flood Area and the Hacienda Ranch Flood Basin, Kings County, were both created specifically, and are used as needed, for this purpose. Although not designed as a storage basin, agricultural fields in the old Tulare lakebed may be used to store floodwaters when the other storage basins are full. Finally, the Lemoore Naval Air Station sewage ponds have been used rarely by nesting Caspian terns.

Tulare Basin Sites Without Management Potential

At virtually all Tulare Basin sites the terns are limited by the availability of stable nesting sites safe from ground predators. Thus, no sites within this region provide management potential.

At the sets of evaporation ponds, terns have nested intermittently on internal levees surrounded by ponds with water (TLDD South, Westlake South) or on small islands exposed by lowered water levels (Westlake North). The number of cells and the depth to which they are flooded varies with climatic fluctuations and the acreage of nearby irrigated fields, which may depend on commodity prices and farm subsidies. The evaporation ponds generally are too salty to support fish. Hence, the terns apparently forage in nearby drainage canals, where available fish are inland silverside, mosquitofish, carp, and striped bass. Terns perhaps also sometimes forage on additional species of fish carried to nearby floodwater storage basins from upslope streams and reservoirs. The ability to enhance tern habitat on the evaporation basins seems very limited, as management for agricultural purposes may conflict with maintaining suitable nesting habitat. Lack of insular nesting sites also would make it difficult to maintain long-term colonies. The small number of terns that have nested and typically failed at the Westlake ponds (North Basin, 10 nests in 1993, 8 nests in 1994; South Basin, 3 nests in 1998) suggests that nearby foraging habitat may also be limiting or that predator pressure is too intense. Although numbers of breeding terns have been higher at the TLDD South Evaporation Basin (~400 pairs in 1985, 40 nests in 1998) than at the Westlake ponds, nesting at the former basin has been intermittent. Nesting is discouraged at the basins with high selenium levels in the water to limit potential exposure of breeding birds to contamination from this source. For this reason, currently tern nesting is effectively precluded at TLDD South by the intense hazing used to discourage nesting birds.

In years of very high runoff, the South Wilbur Flood Area and Hacienda Ranch Flood Basin hold surplus water for later use in irrigation of nearby agricultural fields. These sites are dry in many years, and their size can vary dramatically depending on the amount of available water, which is typically a function of climatic variation. The South Wilbur tends to hold water more frequently than Hacienda Ranch, which is typically flooded only in extremely wet years. Consequently, nesting of Caspian terns at these sites is intermittent. The South Wilbur was used by nesting terns at least in 1982 (450 “breeding”), 1998 (70 nests), and 1999 (~114 pairs) and the Hacienda Ranch in 1987 (“200 including many chicks”). Terns nesting at South Wilbur have used barren, broken-levee islands for nesting, and the nest site at Hacienda Ranch was not described. In extremely wet years (e.g., following an El Niño winter) these basins may reach capacity, and

additional floodwaters may be stored opportunistically within agricultural fields in the historic Tulare lakebed. This was the case in 1998 when ~20 pairs nested on a broken levee island ~15 km east of Kettleman City within an extensive area of flooded fields. Given the intermittent availability of water and current management to serve agricultural needs, opportunities for enhancement of these sites for nesting terns is limited.

About 20 pairs of Caspian terns nested on an internal levee of the Lemoore Naval Air Station sewage ponds in 1998. There appears to be limited potential for enhancement of this site for terns given plans to haze birds there in 2003 because of concerns of possible selenium contamination. The single prior nesting record for Caspian terns also suggests that foraging habitat in the vicinity of this site may be marginal.

SOUTHERN INTERIOR CALIFORNIA

The Salton Sea is within a below-sea-level trough in the Colorado Desert of Riverside and Imperial counties. Before it was tamed, the Colorado River periodically shifted course to the Salton Trough, where it formed ancient Lake Canuilla. With the Colorado Rivers' eventual shift back to its predominant path to the Gulf of California, Lake Cahuilla would increase in salinity and ultimately dry to an alkaline playa. From 1905-1907, failure of a diversion structure caused floodwaters of the Colorado River to flow unchecked into the Salton Trough, creating the present day Salton Sea.

Today, agricultural drainage, augmented by mountain runoff and urban effluent, now supplies the Salton Sea. Despite the freshwater inflow, the sea's salinity is increasing because of the extreme desert temperature and lack of outflow from this terminal basin. The Salton Sea covers over 615 sq. km (380 sq mi) and its surface elevation is about 70 m (227 ft) below sea level (USFWS 1999). Colorado River diversions currently supports extensive irrigated agriculture in the Coachella Valley to the north of the sea and particularly, in the Imperial Valley to the south. The Imperial Irrigation District is considering transfer of 300,000-400,000 acre feet of water to San Diego.

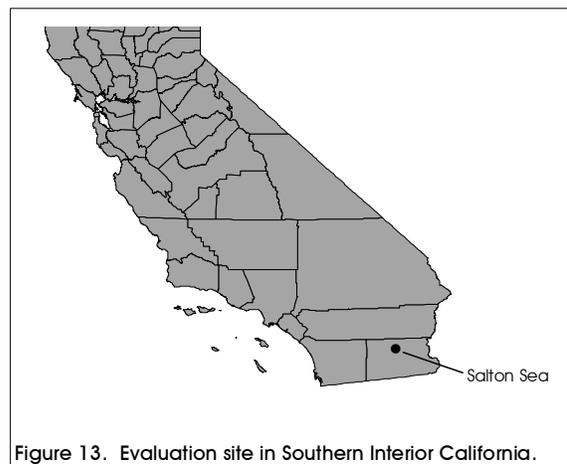


Figure 13. Evaluation site in Southern Interior California.

After the Salton Sea was formed, the salinity began to rise as a result of evaporation. As this occurred, the native freshwater fish species began to die off. When the salinity reached nearly the same level as the Pacific Ocean, attempts were made to introduce several marine fish. There is now an established fishery for these saltwater fish. The Federally and State endangered desert pupfish (*Cyprinodon macularius*) can be found in the freshwater drainages next to the Salton Sea. However, impacts from Caspian terns are minimal if any (C. Pelizza, USFWS, pers. comm.). The most abundant fish, tilapia (*Oreochromis mossambicus*) is an African exotic that entered the sea as an escapee from adjoining fish farms.

At the Salton Sea, there are four islands or sets of islands (all at the south end) that Caspian terns have used for nest sites: Mullet Island, Morton Bay islands, Obsidian Butte Island, and Headquarters Unit D Pond islands. Some of these islands are located within the Sonny Bono Salton Sea NWR (Refuge). After a decade-long absence, nesting Caspian terns recolonized the sea in 1992 (30 pairs), reached a peak of 1,500 pairs in 1996, and declined to 327 pairs in 2001 (Shuford and Craig 2002). Tern reproductive success is affected by extreme environmental conditions as demonstrated by the high mortality of fledglings from heat stress (K. Molina pers. comm.). Causes for the fluctuations of this population are unknown, but may reflect changing prey availability as nesting habitat does not appear to be limited.

Southern Interior California Sites Without Management Potential

Sites assessed in the Southern Interior California region do not provide management opportunities for tern relocation because of the uncertainties of water and prey issues at Salton Sea. If the proposed water transfer occurs, lake levels will slowly lower (C. Pelizza pers. comm.) and it is unclear what lies in the future for existing islands. Mullet Island, Morton Bay Islands, and Obsidian Butte Island will likely be connected to the shoreline (C. Pelizza pers. comm.). This will reduce nesting habitat for many colonial nesting species, including Caspian terns. Increasing salinity with declining water levels may also cause the sea's fish populations to decline. In addition, an aging population structure of tilapia may explain the rapid increase and decline of the nesting populations of the Caspian tern and other fish-eating birds, such as the double-crested cormorant, in the 1990s. Thus, although there may be opportunities to create nesting habitat in Refuge impoundments, it is unclear if fish are currently of adequate size and abundance to support additional numbers of terns. Efforts should be made to protect and enhance existing habitat so that it will be suitable for nesting terns in years with the right water and prey conditions.

Mullet Island, Morton Bay Islands, and Obsidian Butte Island: These islands are found within the Salton Sea proper. Mullet Island is owned by the Refuge whereas Morton Bay and Obsidian Butte islands are owned by the Imperial Valley Irrigation District. As mentioned earlier, if water is transferred to the coastal cities, Mullet Island, Obsidian Butte Island, and the Morton Bay islands would very likely become part of the mainland. Mammalian predators would then have direct access to the colony nest sites, which would force Caspian terns to seek out more favorable habitat elsewhere. Even if nesting habitat is available, it is unclear if enough fish of adequate size to support additional numbers of nesting terns is available. Thus, these sites provide no management opportunities for Caspian terns.

Headquarters "D" Pond, Impoundments 1-A4 and 1-B4 of Unit 1: These impoundments are part of a series of freshwater wetland impoundments on the Refuge's Union Tract and are located near the end from the water inflow. Therefore, the water has a slightly elevated salinity level by the time it reaches these units. All of the impoundments are surrounded on three sides by agricultural fields and to the north by the Salton Sea. Some islands are located within Headquarters "D" and Unit 1-B4. In the past, terns have nested within Headquarters "D" pond only. The impoundments dry out by summer, therefore a prey base is not maintained within the

ponded areas. However, the Salton Sea is less than 200 m (656 ft) to the north. The Refuge has plans to develop islands within the impoundment for use by nesting colonial birds (*C. Pelizza pers. comm.*). Reproductive success of terns nesting on these islands within these impoundments may still be affected by heat stress and a fluctuating prey base. Thus, because of the same uncertainties associated with the Sea as water level and prey availability mentioned above, these sites do not have a high potential to support relocated Caspian terns.

SUMMARY

A total of 77 individual sites were evaluated in this study, including 30 in coastal areas and 47 in interior regions. Table 7 lists all sites evaluated and the determination of the sites' management potential for supporting breeding Caspian terns in the Pacific Coast/Western region. The initial determination of a sites' management potential involved several considerations: (1) suitability of existing habitat or the amount and type of habitat enhancement required to make it suitable for Caspian terns, (2) site stability or long-term habitat availability, (3) the ability of the site to support a substantial number of breeding terns, (4) abundance and type of available prey resources, (5) presence of potential predators (mammalian and avian), and (6) expected levels of natural or human disturbance. Sites located in or near the Columbia River (e.g., Mid-Columbia River and Potholes Reservoir sites) were eliminated from further consideration because specific activities to enhance Caspian tern colonies in these locations would not contribute to the goal of reducing impacts to listed Columbia River salmonids.

Twenty-four sites were determined to have management potential for Caspian terns on the basis of initial site assessments. Seven sites are located in Washington, 4 sites in Oregon, and 13 sites in California. These 24 sites were further evaluated using a two-tiered process to rank sites according to their potential to serve as habitat for some of the terns currently nesting on East Sand Island. Six sites were categorically ranked as sites with high management potential, fourteen were categorized as sites with moderate management potential, and four were categorically ranked as sites with low management potential. Two sites assessed in this report were partially or entirely in private ownership. Landowner support will determine if these sites will be considered for future Caspian tern management. On publically owned lands, land management status and existing land use plans will need to be reviewed with managers to ensure enhancement activities for Caspian terns are compatible with land use designations.

The determination of management goals and any specific site selection for development of Caspian tern nesting habitat will require close collaboration among agencies and an extensive process of public input. Management goals, opportunities, and alternatives will be developed and assessed in the EIS for the management of Caspian tern smolt predation in the Columbia River estuary. As stipulated in the 2002 Settlement Agreement, the EIS process will be initiated in the spring of 2003 with a Notice of Intent and Public Scoping. Scoping provides agencies and the general public a forum to identify concerns, opportunities, and issues. Specific outreach to public and private site owners, communities, local jurisdictions, Federal and state legislative representatives, and other stakeholders will begin immediately to fully inform stakeholders of

the issues at hand, the decisions to be made, and the process and tasks scheduled for the months and years ahead. This will allow stakeholders an opportunity to participate in the earliest stages of developing alternatives for further consideration.

In addition to the EIS Public Scoping process, it will be necessary to identify research and information needed to adequately assess the appropriateness of enhancing or establishing tern colonies at alternate sites. It is important to begin studies in 2003 to assess factors such as prey base composition, tern diet composition, and relocation techniques so that results can be considered in the EIS decision-making process scheduled to conclude in 2005. Findings presented in this Feasibility Assessment, and those of affiliated reports and research, will provide managers a biological foundation for the development of management options with the best potential to meet the multiple goals of reducing tern predation on Columbia River salmonids while conserving Caspian terns and avoiding unacceptable impacts at any site selected for management.

TABLE 7. Assessment of Caspian tern habitat management potential at 77 sites in the Pacific Coast/Western region.

Site Name	Management Potential		Factors limiting Management Potential
	Yes	No	
COASTAL WASHINGTON			
Sand Island, Grays Harbor	x		
No Name Island, Grays Harbor	x		
Unnamed Island, Grays Harbor	x		
Cate Island, Grays Harbor	x		
Bldg 407, Commencement Bay		x	Landowner will discourage birds
McNeil Island, Puget Sound		x	No site available
Snag Islands, Willapa Bay		x	No stable nesting habitat
Unnamed Island, Padilla Bay	x		
Jetty Island, Puget Sound	x		
INTERIOR WASHINGTON			
Solstice Island, Potholes Reservoir		x	Fluctuating reservoir water levels
Unnamed Island, Potholes Reservoir		x	Fluctuating reservoir water levels
Harper Island, Sprague Lake		x	Poor nesting substrate
Unnamed Island # 1, Banks Reservoir		x	Fluctuating reservoir water levels
Unnamed Island #2, Banks Reservoir		x	Fluctuating reservoir water levels
Goose Island, Banks Reservoir		x	Fluctuating reservoir water levels
MID-COLUMBIA RIVER			
Crescent Island		x	Will not reduce Columbia River impacts
Straight Six Island, Umatilla		x	Will not reduce Columbia River impacts
No Name Island #1, Umatilla		x	Will not reduce Columbia River impacts
No Name Island # 2, Umatilla		x	Will not reduce Columbia River impacts
No Name Island #3, Umatilla		x	Will not reduce Columbia River impacts
“Test” Island, Umatilla		x	Will not reduce Columbia River impacts
Miller Rocks		x	No available habitat
Threemile Canyon Island		x	Will not reduce Columbia River impacts
COASTAL OREGON			
Unnamed Island, Coos Bay	x		
“South” Island, Coos Bay		x	Heavily vegetated, heavy boat traffic
“Middle” Island, Coos Bay		x	Heavily vegetated, heavy boat traffic

TABLE 7. (cont.) Assessment of Caspian tern habitat management potential at 77 sites in the Pacific Coast/Western

Site Name	Management Potential		Factors limiting Management Potential
	Yes	No	
“North” Island, Coos Bay		x	Heavily vegetated, heavy boat traffic
Unnamed Island, Umpqua River Estuary	x		
Steamboat Island, Umpqua River Estuary	x		
Fern Ridge Reservoir, Oregon	x		
INTERIOR OREGON/NEVADA			
Pelican/Crump Lake, Oregon		x	Site availability varies annually
Summer Lake, Oregon		x	Site availability varies annually
Tern Island, Malheur Lake		x	Site availability varies annually
Anaho Island, Pyramid Lake		x	Inadequate prey base
Stillwater National Wildlife Refuge		x	Site availability varies annually
Carson Sink, Nevada		x	Site availability varies annually
SOUTHERN IDAHO			
Unnamed Island, Mormon Reservoir		x	Site availability varies annually
Tern Island, Minidoka NWR		x	Site availability varies annually
Gull Island, American Falls Reservoir		x	Site availability varies annually
Gull Island, Blackfoot Reservoir		x	Site availability varies annually
Unnamed Island, Bear Lake NWR		x	Site availability varies annually
NORTHERN COASTAL CALIFORNIA			
Sand Island, Humboldt Bay	x		
Knight Island, San Pablo Bay	x		
Brooks Island, San Francisco Bay	x		
Runway wetland, Alameda NWR	x		
West wetland, Alameda NWR	x		
Pond A7, South San Francisco Bay	x		
Pond A16, South San Francisco Bay	x		
Pond 10, Baumberg Tract, San Francisco Bay	x		
Elkhorn Slough, Monterey Bay	x		
Salinas River, Monterey Bay		x	Incompatible with management for snowy plovers
SOUTHERN COASTAL CALIFORNIA			
Terminal Island, Los Angeles Harbor		x	Limited habitat

TABLE 7. (cont.) Assessment of Caspian tern habitat management potential at 77 sites in the Pacific Coast/Western

Site Name	Management Potential		Factors limiting Management Potential
	Yes	No	
Upper Newport Bay Ecological Reserve, Newport	x		
Bolsa Chica Ecological Reserve, Huntington Beach	x		
South San Diego Bay NWR, Saltworks		x	Limited habitat
NORTHEASTERN CALIFORNIA			
Meiss Lake, Butte Valley Wildlife Area		x	Site availability varies with annual precipitation
Lower Klamath NWR	x		
Tule Lake NWR	x		
Clear Lake NWR		x	Site availability varies with annual precipitation
Goose Lake		x	Site availability varies with annual precipitation Site
Bird Island, Big Sage Reservoir		x	Site availability varies with annual precipitation Site
Honey Lake Wildlife Area		x	Site availability varies with annual precipitation Site
Mono Lake		x	Inadequate prey in close proximity
TULARE BASIN			
Lemoore Naval Air Station		x	Site availability varies with annual precipitation Site
Westlake Farms North Evaporation Basin		x	Site availability varies with annual precipitation Site
Tulare Lakebed		x	Site availability varies with annual precipitation Site
Westlake Mitigation Wetland, section 3		x	Site availability varies with annual precipitation Site
Westlake Farms South Evaporation Basin		x	Site availability varies with annual precipitation Site
South Wilbur Flood Area		x	Site availability varies with annual precipitation Site
Hacienda Ranch Flood Basin		x	Site availability varies with annual precipitation Site
Tulare Lake Drainage District, South Evaporation Basin		x	Site availability varies with annual precipitation Site availability varies annually
SOUTHERN INTERIOR CALIFORNIA			
Obsidian Butte, Salton Sea		x	Long-term availability of site uncertain
Morton Bay, Salton Sea		x	Long-term availability of site uncertain
Headquarters Unit "D," Salton Sea		x	Long-term availability of site uncertain
Mullet Island, Salton Sea		x	Long-term availability of site uncertain
Unit 1-B4, Salton Sea NWR		x	Long-term availability of site uncertain
Unit 1-A4, Salton Sea NWR		x	Long-term availability of site uncertain
^a No survey conducted			
^b Suspected nesting but not confirmed			

TABLE 8A. Potential Caspian tern management sites ranked by Tier I criteria and Categorical Factor assignments.

Sites with Management Potential	Ranking Criteria						Sum of Tier I Ranks	Categorical Factor
	Site Status ^a	Potential Conflict with Salmon ^b	Proximity to East Sand Island ^c	Site Capacity ^d	Conflicts with other listed species (non-salmonids) ^e	Site Availability ^f		
COASTAL WASHINGTON								
Sand Island, Grays Harbor	3	3	3	5	3	5	22	H
No Name Island, Grays Harbor	0	3	3	5	3	3	17	M
Unnamed Island, Grays Harbor	0	3	3	3	3	5	17	M
Cate Island, Grays Harbor	0	3	3	3	3	3	15	M
Whitcomb Island, Grays Harbor	3	3	3	5	3	0	17	M
Unnamed Island, Padilla Bay	3	3	1	1	5	3	16	M
Jetty Island, Puget Sound	0	3	1	5	5	3	17	M
COASTAL OREGON								
Unnamed Island, Coos Bay	0	3	2	1	3	3	12	L
Unnamed Island, Umpqua River Estuary	0	3	2	1	5	3	14	L
Steamboat Island, Umpqua River Estuary	0	3	2	1	5	3	14	L
Fern Ridge Reservoir	0	3	2	5	5	0	15	M
NORTHERN COASTAL CALIFORNIA								
Sand Island, Humboldt Bay	5	3	1	1	5	5	20	H
Knight Island, San Francisco Bay	5	3	1	3	5	3	20	H
Brooks Island, San Francisco Bay	5	3	1	5	5	5	24	H
Runway wetland, Alameda, San Francisco Bay	3	3	1	3	3	3	16	M
West Wetland, Alameda, San Francisco Bay	3	3	1	3	3	3	16	M

TABLE 8A. (cont.) Potential Caspian tern management sites ranked by Tier I criteria and Categorical Factor assignments.

Sites with Management Potential	Ranking Criteria						Sum of Tier I Ranks	Categorical Factor
	Site Status ^a	Potential Conflict with Salmon ^b	Proximity to East Sand Island ^c	Site Capacity ^d	Conflicts with other listed species (non-salmonids) ^e	Site Availability ^f		
Salt Pond A7, South San Francisco Bay	5	3	1	3	3	3	18	H
Salt Pond A16, South San Francisco Bay	0	3	1	1	3	5	13	L
Baumberg Pond, San Francisco Bay	5	3	1	1	3	3	16	M
Elkhorn Slough, Monterey Bay	5	5	1	1	3	3	18	H
SOUTHERN COASTAL CALIFORNIA								
Bolsa Chica Ecological Reserve, Huntington Beach	5	5	1	3	3	0	17	M
Upper Newport Bay Ecological Reserve, Newport Beach	0	5	1	3	3	3	15	M
NORTHEASTERN INTERIOR								
Lower Klamath NWR	3	5	1	3	5	0	17	M
Tule Lake NWR	3	5	1	3	5	0	17	M

^a Site Status: 5 = nesting colony currently active, 3 = historic nesting colony, 0 = no recorded Caspian tern nesting

^b Conflict with salmonids: 5 = salmon not available as potential prey item, 3 = salmon present as potential prey but good abundance of non-salmonid prey items, 1 = salmon comprises primary prey base

^c Proximity to East Sand Island: 3 = site less than 200 km from East Sand Island, 2 = site 200-500 km from East Sand Island, 1 = site greater than 500 km from East Sand Island

^d Site Capacity: 5 = greater than 2000 nesting pairs, 3 = 350-1000 nesting pairs, 1 = less than 350 nesting pairs

^e Conflicts with other listed species or species of concern (non-salmonids): 5 = no listed species present, 3 = listed species present but low likelihood of conflict, 1 = listed species present and relatively high potential for conflict

^f Site Availability: 5 = site currently suitable or requires minimal habitat enhancement, 3 = site available after extensive manipulation, 0 = site needs to be constructed

TABLE 8B. Potential Caspian tern management sites ranked by Tier II criteria and Total Site Scores.

Sites	Ranking Criteria			Sum of Tier II Ranks	Total Site Score
	Habitat Management ^a	Human Disturbance ^b	Potential Predators ^c		
High Category (*5)					
Elkhorn Slough, Monterey Bay	2	3	1	6	30
Sand Island, Grays Harbor	2	5	3	10	50
Brooks Island, San Francisco Bay	2	3	5	10	50
Sand Island, Humboldt Bay	3	5	5	13	65
Knight Island, San Francisco Bay	3	5	5	13	39
Salt Pond A7, South San Francisco Bay	3	5	5	13	39
Medium Category (*3)					
Unnamed Island, Grays Harbor	3	5	5	13	39
No Name Island, Grays Harbor	2	5	3	10	30
Whitcomb Island, Grays Harbor	3	5	5	13	39
Cate Island, Grays Harbor	2	3	1	6	18
Unnamed Island, Padilla Bay	2	5	3	10	10
Jetty Island, Puget Sound	1	3	3	7	21
Fern Ridge Reservoir	2	5	5	12	12
Runway wetland Alameda NWR, San Francisco Bay	2	5	1	8	24
West Wetland, Alameda NWR, San Francisco Bay	2	5	1	8	24
Baumberg Pond, San Francisco Bay	3	5	5	13	13
Bolsa Chica Ecological Reserve, Huntington Beach	2	5	5	12	36
Upper Newport Bay Ecological Reserve, Newport Beach	2	5	3	10	30

TABLE 8B. (cont.) Potential Caspian tern management sites ranked by Tier II criteria and Total Site Scores.

Sites	Ranking Criteria			Sum of Tier II Ranks	Total Site Score
	Habitat Management ^a	Human Disturbance ^b	Potential Predators ^c		
Lower Klamath NWR	1	5	5	11	33
Tule Lake NWR	1	5	5	11	33
Low Category (*1)					
Unnamed Island, Coos Bay	1	5	5	11	11
Unnamed Island, Umpqua River Estuary	1	5	5	11	11
Steamboat Island, Umpqua River Estuary	3	5	5	13	13
Salt Pond A16, South San Francisco Bay	3	5	5	13	13

^aHabitat maintenance: 3 = short-term or infrequent management requirements, 2 = annual habitat maintenance but no heavy equipment required, 1 = annual maintenance and heavy equipment required

^bHuman disturbance: 5 = site is relatively inaccessible and no established human use, 3 = site is accessible with a history of human use; disturbance levels are manageable, 1 = site is readily accessible with regular human use and limited opportunities for managing use

^c Predators: 5 = inaccessible to mammals and no known concentration of avian predators in close proximity, 3 = avian and/or mammalian predators on site, but potential impacts to tern colony are low or manageable, 1 = site accessible to mammals and high concentration of avian predators on-site or nearby

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