# 8.0 RECOMMENDATIONS

***Section Topics:***

***8.1 Methods to Minimize Impacts***

***8.2 Methods to Improve Impact Assessment and Streamline Environmental Review and Permitting***

***8.3 Regional Management of Cumulative Impacts and Ecosystem Benefits***

This report section addresses the following question of the CSMW.

- *How can potential impacts from sediment management activities to coastal biota and ecosystems be minimized in order to reduce the concerns of the regulatory community and streamline permitting of sediment management activities?*

Objectives of this study include providing the following types of recommendations:

- Provide recommendations for protecting California's resources during sediment management activities based on current understanding of potential impacts.
- Provide science-based recommendations to address critical information gaps.
- Provide recommendations to reduce environmental concerns and streamline permitting of sediment management activities.

*Photo credit: Danny Heilprin, SAIC*

The recommendations presented in this section emphasize the following considerations:

- Protective environmental design of sediment management projects.
- Effective monitoring and operational controls during project implementation.
- Focused monitoring to fill critical information gaps on linkages between coastal processes-biological responses and impact management.
- Establishment of thresholds of significance relevant to sediment management projects.
- Effective use of an informal coordination process with resource agencies and interested stakeholders to achieve multiple use objectives at local and regional scales.
- Development of tools, guidelines, and processes to facilitate more effective management of ecosystem and cumulative impacts on a regional basis.
- Recognition and Incorporation of ecosystem benefits into economic cost-benefit formulations so environmentally sound sediment management becomes the preferred alternative.

Section 8.1 recommends methods for minimizing impacts. Section 8.2 suggests methods to improve impact assessment and streamline environmental review and permitting of future projects. Section 8.3 recommends actions to improve management of cumulative impacts and ecosystem benefits associated with regional sediment management.

## 8.1 Methods to Minimize Impacts

There are several mechanisms to minimize impacts associated with sediment management projects. General recommendations are given below and more detailed descriptions of measures are provided in Section 6.

Pre-construction project design is probably the most important consideration for minimizing adverse ecological impacts from sediment management activities. Opportunities to minimize impacts also are present during project implementation by use of environmentally sensitive construction methods, operational controls, and compliance monitoring. Just as project design is unique to the specific objectives and constraints that shape the definition of each project, so too are the considerations associated with minimizing biological impacts. The recommendations provided below address each of the main components associated with project design and implementation. The applicability of the recommendations to any particular project will depend on the following key factors:

- Project design,
- Construction schedule,
- Construction implementation controls and monitoring, and
- Frequency of activity.

### *8.1.1 Project Design*

The primary objective with environmental project design is to appropriately match design with environmental constraints so that impacts are kept below critical thresholds. An effective feedback loop between project engineers and biologists is recommended to achieve environmentally sensitive project designs.

Important design considerations include environmental constraints, placement location, project size, sediment characteristics, and construction schedule.

#### 8.1.1.1 <u>Environmental Constraints</u>

- Conduct pre-construction surveys and/or environmental review to identify sensitive habitats and sensitive species in area of potential effect and refine design to avoid significant direct and indirect impacts to these resources from project implementation.
- Evaluate beach receiver sites for potential habitat suitability for California grunion spawning based on physical substrate characteristics (sand depth, cobble or other hard substrate cover) and beach width (i.e., available sand habitat above the average neap high tide line associated with the project schedule). Because habitat suitability may vary seasonally; i.e., become more suitable between spring and summer as sand accretion occurs, habitat suitability should be evaluated 30 days before any scheduled placement activity.
- Conduct pre-construction surveys to refine vessel, anchoring, and temporary pipeline locations if sensitive resources occur in the area.

#### 8.1.1.2 Placement Location

- Select beach placement locations for nourishment and shoreline protection objectives that avoid direct impacts to sensitive habitats and species and minimize potential indirect turbidity and sedimentation impacts to sensitive nearshore habitats.

- Select beach placement locations for harbor and lagoon maintenance projects with consideration given to historic use frequency, morphodynamics of beach (if there is choice, select intermediate erosive beach over relatively flat dissipative beach), and potential for occurrence of sensitive species. If sensitive species have potential to occur, include mitigation measures that either restrict construction schedule to outside their occurrence period or implement monitoring and protective measures (e.g., buffers, temporarily halt construction) during construction.

- Select beach and nearshore placement locations that are downcurrent and sufficient distance from inlets to coastal lagoons, creeks, and rivers to minimize increased sedimentation and maintenance requirements for these small water bodies and to avoid interference with migratory runs of salmonids, where applicable.

- Select nearshore placement locations that are sufficient distance from sensitive habitats (kelp beds, surf grass beds, eelgrass beds) to avoid significant turbidity and sedimentation impacts.

- Select locations for sand mining (borrow sites) that are sufficient distance from sensitive habitats (kelp beds, surf grass beds, eelgrass beds) to avoid significant turbidity and sedimentation impacts.

#### 8.1.1.3 Project Size and Configuration

- Appropriately match project size to biological constraints. For example, this may involve placement of a larger volume in an area with little environmental constraints to serve as a feeder beach to downdrift beaches, and/or placement of small to mid size volumes at multiple sites to promote more gradual sediment transport and minimization of potential impacts to sensitive resources.
- Excavate coastal sand mining areas (borrow sites) to relatively shallow depths to avoid creation of deep pits with altered biological resources. Incorporate refuges into design to facilitate rapid recovery.

### *8.1.2 Construction Schedule*

The Corps has concluded that information necessary to formulate technically sound environmental work windows is generally inaccessible or unavailable and has led to restricted project flexibility, cost, and inconsistent application of windows among Corps Districts (Reine et al. 1998). Different work window and schedule restrictions to avoid impacts to threatened and/or endangered and other managed sensitive species are reported

in various environmental documents, permits, sediment management plans, and on-line information sources. This study identified inconsistencies in application of environmental windows within and among different geographic locations in California.

It is recommended that the CSMW coordinate a workshop with resource and regulatory agencies to review existing criteria to guide when environmental work windows for dredging and beach nourishment are appropriate. Review of projects from California and other areas of the United States indicate similarities in turbidity plume and deposition processes that suggest buffers may be effective operational controls. Information on noise levels also permit determination of appropriate buffers to below harassment levels for sensitive wildlife. Other operational controls combined with monitoring appear to be effective at avoiding adverse impacts to sensitive wildlife. Furthermore, project size is an important consideration with respect to impact exposure duration. Nevertheless, there are circumstances when environmental window restricted periods are the most effective protective measures, particularly when proximity controls cannot be satisfied and/or in confined channels and basins where potential risk for impact is higher.

### *8.1.3 Construction Implementation Controls and Monitoring*

The environmental objective during construction should be to control activities to avoid significant impacts and minimize adverse impacts. When possible, projects should be implemented in a way that is analogous to natural events so tolerance responses and recovery following natural processes are maximized. Important considerations during project implementation include pre-construction coordination, operational controls, compliance monitoring, and documentation of mitigation effectiveness.

Mitigation measures and monitoring associated with pre-construction and construction phases of sediment management projects are reviewed in detail in Sections 6 and 7. The following recommendations focus on activities that if implemented could increase consistency and improvement in environmental protection during implementation of sediment management projects.

#### 8.1.3.1 Pre-Construction Coordination

- Conduct early informal coordination with resource agencies to review EFH and sensitive species mitigation measures (see Section 6.6.2)
- If commercial fishing activities occur in the project area, pre-coordination with local commercial fishing organizations is recommended to ensure important fishery grounds are protected and minimal interference to fishing activities. Impact assessments of managed fisheries at a project-specific level may be challenging as a result of limited information on spawning grounds, fishing areas, and use patterns at a local level. Fishing organizations have expressed concerns with beach nourishment projects involving beach and/or nearshore placement of sand in areas with important fisheries. An informal coordination process with local fishing organizations and resource agencies (CDFG, NMFS) is recommended to facilitate exchange of relevant information to improve CEQA/NEPA evaluations by having better understanding of local fishery impact areas of concern, agreement on significance thresholds, and

identification of mitigation measures to minimize interference with local uses while ensuring appropriate resource protection.

#### 8.1.3.2 Standardized Monitoring

***Standardize Water Quality Compliance Monitoring to Increase Biological Relevance***

There is little standardization among RWQCB water quality monitoring requirements associated with sediment management activities in California. Differences exist in what has been required to be monitored, methods of monitoring, locations of monitoring relative to distance from dredge and/or disposal sites, and frequency of monitoring. These limitations hamper the identification of near field and far field zones of influence and associated measured values, which in turn makes it difficult to develop science-based buffers for protection of sensitive resources from water quality impacts during sediment management operations. It is recommended that the CSMW lead a workshop with resource and regulatory personnel to review and discuss representative water quality data associated with sediment management activities, biological relevance of monitored variables and measured values, and recommendations for standardizing water quality monitoring requirements for future sediment management projects (Section 8.2.3). Standardized monitoring not only would be useful for defining protective buffers, but also could simplify environmental impact analysis of future projects.

***Increase Standardization of Methods Used to Monitor Sediment Management Projects***

An often cited criticism is that there has been little standardization in the design and methods of environmental studies of beach nourishment projects, and that they have been limited in scope and duration (NRC 1995, Greene 2002, Bishop and Peterson 2005). Consequently, many of the environmental concerns with respect to beach nourishment have not been resolved over the last decade when this deficiency was pointed out. Monitoring guidance recently was prepared to support MMS surveys of potential borrow sites on the East and Gulf Coasts of the United States. Standardized guidelines for monitoring beach nourishment projects of different size would help streamline environmental review. It is recommended that the CSMW lead a workshop with resource agencies to review monitoring guidance and reporting standards (Section 8.2.3). The outcome of the workshop could be used to refine the methods presented in Section 7 of this report and/or to prepare a separate technical guidance document.

#### 8.1.3.3 Monitoring Feedback Loop to Adaptive Management

- Activities undertaken after construction may include monitoring to assess project performance and implementation of additional mitigation measures, if required. Post construction monitoring of project performance may be a permit requirement for certain projects based on considerations of project size and proximity to sensitive habitats. The objective of this type of monitoring is to directly evaluate and verify no significant impacts to sensitive biological resources.

- It is recommended that any post construction biological monitoring be conducted using a BACI (Before-After, Control-Impact) survey design. The need for this type of monitoring should be identified during environmental review and included in the mitigation, monitoring, and reporting program (MMRP) developed for the project. Definition of what constitutes significant impact and how such an impact would be identified (including statistical analysis) by the monitoring program should be specified in the MMRP. In addition, the MMRP should include definition of appropriate compensatory and/or restoration mitigation including success criteria and inclusive costs to implement mitigation including appropriate construction, monitoring, and reporting elements.
- It is recommended that monitoring be conducted to evaluate potential impacts when project designs substantially differ from previously permitted projects within the project area. Considerations may include substantial increases in project volume, use sands that differ by more than 10 percent from receiver site characteristics, substantially modified project location boundaries, and/or use of new equipment and/or technologies. Monitoring should follow a BACI survey design and include specification of how data will be used to evaluate project impacts and/or the effectiveness of new equipment/technologies.

#### 8.1.3.4 Documentation of Mitigation Effectiveness

Different protective measures have been employed to minimize impacts during construction. However, limited monitoring data are available for assessing the effectiveness of protective measures. It is recommended that any permit required monitoring programs include a field on data sheets that identifies what protective measures, if any, were in effect during monitoring, and specification of how data will be used to facilitate evaluations of the effectiveness of protective measures in the monitoring report.

### *8.1.4 Frequency of Sediment Management Activity*

A substantial volume of literature and reports document that benthic community structure is related to frequency of disturbance. Generally, simpler communities dominate frequently disturbed habitats and diversity increases with less disturbance. In the context of sediment management projects, this means that areas subject to regular maintenance dredging generally have a lower habitat quality than less frequently dredged areas in embayments. Along the shore, sandy beach habitats generally support less diverse benthic communities due to the high energetic surf zone than communities in the nearshore and offshore. The biota that use the beach habitat, however, are naturally adapted to the disturbance associated with sand erosion in winter and accretion in summer, displaying seasonal cycles of recruitment and productivity. Fish display seasonal onshore and offshore migration and many of birds that frequent the shores are seasonal migrants. Therefore, frequency of beach nourishment may be less of an issue for sandy beach habitat when projects are scheduled to avoid and/or minimize disturbance of spring-summer benthic recruitment periods. Factors such as project size and disturbance regimes at other beach sites in the region should be considered to avoid and/or minimize the potential for cumulative impacts to wildlife (fish, shorebirds) dependent on a healthy invertebrate forage base if projects schedules extend into spring recruitment periods.

It is recommended that design strategies and/or watershed management be incorporated into project design to decrease the frequency of sediment management activities, where feasible. Design strategies may include avoidance of repetitive disturbance at a frequency that degrades ecosystem function, incorporation of dune restoration and/or rehabilitation into beach nourishment projects to enhance ecological function and longevity of fill performance, and use of sedimentation basins and source control to decrease the frequency of maintenance dredging. ,

Nearshore habitats generally experience substantial disturbance less frequently. Notable exceptions include ENSO events when high wave conditions may result in substantial sand movement and scour much farther offshore than typical under average wave conditions (or hurricane in other parts of the United States). Other exceptions may include areas with strong currents such as where ridge-and-swell topography occurs or near canyons and slope areas. These differences in natural resilience to disturbance should be considered with respect to sediment management projects involving nearshore or profile placement or offshore borrow site dredging. Slow recovery rates (years) to disturbance generally occur unless activities occur in areas naturally subject to frequent disturbance. It is recommended that factors such as project size, area of disturbance, and frequency of disturbance be given careful consideration to avoid cumulative impacts associated with use of nearshore and offshore habitats for sediment management activities.

## 8.2 Methods to Improve Impact Assessment and Streamlining Environmental Review and Permitting

The recommendations address streamlining throughout impact assessment, environmental review, and permitting. Recommendations address the following elements:

- Establish Standardized CEQA thresholds of significance,
- Incorporate Protective Measures in Project Description,
- Establish guidelines for impact significance thresholds, protective measures, and monitoring, and
- Fill critical information gaps.

### *8.2.1 Establish Standardized CEQA thresholds of significance*

Thresholds of significance are considered a proven method of streamlining the CEQA process; however, few agencies have formally adopted them and limited attention has been given to thresholds for coastal marine habitats and resources. It is recommended that the CSMW coordinate and encourage local municipalities to adopt thresholds of significance applicable to sediment management projects.

### 8.2.2 Incorporate Protective Measures in Project Description

It is recommended that protective measures to avoid and minimize impacts be incorporated in project descriptions to the maximum extent possible to increase understanding of protective design and resource protection, and to minimize the need for special permit conditions and/or additional mitigation measures.

### 8.2.3 Establish Guidelines for Impact Significance Thresholds, Protective Measures, and Monitoring

It is recommended that the CSMW coordinate workshop(s) with resource and regulatory agencies to review available technical information and develop interim guidelines to facilitate more standardized environmental assessments and streamlined review of projects proposed in areas with sensitive habitats and species. The interim guidelines should be periodically reviewed and adapted as additional information from technical studies and monitoring become available.

It would be useful if the interim guidelines addressed the following types of information with consideration given to differences in impact concern relative to sediment management activity, project size and duration, placement location, and proximity to sensitive resources.

- Critical impact thresholds.
- Construction mitigation measures (e.g., buffers, construction methods, operational controls, monitoring) that may be acceptable under differing project conditions to satisfy EFH and ESA requirements. Priority should be given to developing guidelines for California grunion, California least tern, Dungeness crab, salmonids, and western snowy plover, which are most commonly regulated by environmental window restricted conditions.
- Process and/or methods to obtain relevant information on sensitive fishery grounds in project area of potential effect.
- Compliance monitoring.
- Impact significance monitoring.

### 8.2.4 Fill Critical Information Gaps

#### 8.2.4.1 Beach Nourishment Sediment Compatibility

Minimizing the deviation in grain size characteristics between source and receiver sites is the most often recommended measure to minimize biological impacts from beach nourishment projects (Naqvi and Pullen 1982, NRC 1995, Peterson et al. 2000b, Greene 2002, Speybroeck et al. 2006). Similarly, minimizing change in surface substrate characteristics is recommended to minimize recovery rates of invertebrates after offshore dredging (Hurme and Pullen 1988, Kenny and Rees 1996, Newell et al. 1998, Boyd et al. 2004) and to avoid inferring with the ability of shorebirds to probe the sands for invertebrate prey (Peterson et al. 2002). These recommendations are considered precautionary and ecologically sound based

on current understanding of the importance of animal-sediment relationships.

However, limited information is available with respect to critical thresholds of substrate characteristics to protect biological resources and functions. Several available studies suggest some species are substrate generalists and occur on a broad range of beach types with differing environmental conditions (e.g., *Emerita* sand crabs, Dugan and Hubbard 1996), while others may be adversely affected by coarser sediments or increased silt/clay content (Lassuy and Simmons 1989, McLachlan 1996, Nel et al. 2001).

That animals differ in tolerances to broad or narrowly defined substrate conditions is not surprising given the differences in beach morphodynamic types. Many of the sandy beaches in southern California are of the intermediate bar-trough morphology (Dugan et al. 2000a), which are the most dynamic with respect to erosion and accretion and sand mobility (Wright and Short 1984). Based on considerations of beach morphology and wave climate, it seems reasonable that the definition of sediment compatibility from an ecological standpoint may differ between highly dynamic versus less energetic coastlines. For example, sediment grain size characteristics may vary over a smaller range at less energetic, dissipative beach types than at more dynamic intermediate type beaches. However, this is not addressed in current sediment compatibility definitions, which are generally similar among different areas in the United States.

Better understanding of the range of physical conditions (hydrodynamics, substrate characteristics) defining similar invertebrate forage base characteristics may be useful for optimizing sediment compatibility criteria for local and/or regional environmental conditions. This information also may be useful for assessing environmental performance of opportunistic sand programs such as the SCOUP program, which may involve use of less-than-optimum sands in areas, when appropriate. Having a better understanding of sediment compatibility under different project size, hydrodynamic, and physiographic conditions could contribute valuable technical data to support science-based decisions with respect to optimizing the use of a range of potential available sediment sources in an ecologically sound manner.

#### 8.2.4.2 Turbidity and Sedimentation

There is a need for better empirical data on turbidity and sedimentation during sediment management projects. A major gap in understanding relates to the relevance of laboratory-based effects studies and field studies in areas subject to chronic impacts to the turbidity-sedimentation regimes that actually occur during sediment management projects.

Part of the issue may be resolved by improved standardization and biological relevance of water quality monitoring required to satisfy compliance with 401 Water Quality Certification requirements (Section 8.1.3.2).

Another aspect of the issue relates to a need for advancement in the accuracy of model predictions of sediment transport based on local and regional scales of sediment management planning (Section 8.2.4.3).

One of the most difficult challenges of environmental impact analysis of beach nourishment projects is evaluation of the potential for post project sedimentation impact to sensitive resources. Of particular concern are depth and duration of potential sedimentation since

sensitive habitats and species differ in their tolerances and vulnerabilities to sedimentation. It is recommended that the CSMW coordinate a technical workshop with resource and regulatory agencies to review of analytical strengths and weakness of existing sediment transport models, development of an approach for improving the predictive accuracy of analytical models, and approach for obtaining empirical data during representative beach nourishment projects to provide data necessary for model validation and refinement.

Limited information is available on temporal trends in suspended sediment loads discharged from streams. This data gap if filled could be used to examine relationships of differences in quality of sensitive vegetated and/or reef habitats with distance from inlets and/or suspended sediment discharge loads. Better understanding of these relationships could provide a scientific basis for optimizing sediment management planning decisions with respect to beach nourishment receiver site locations and size in areas with sensitive habitats.

#### 8.2.4.3 Validate and Improve Accuracy of Sediment Transport Models

Predictive models (e.g., GENESIS) have been developed to better understand fate and transport of sediments in coastal environments. A number of environmental variables affect model robustness and prediction accuracy. Monitoring of beach profiles provides empirical data of sand movement cross- and alongshore. Beach profiles may be monitored with beach nourishment projects (e.g., Coastal Frontiers 2004). However, post-project validation of model predictions do not appear to be routinely applied in California (R. Boudreau and D. Cannon, 2007 personal communications). This data gap limits adaptive improvement in the accuracy of model predictions under local conditions based on empirical data and lessons learned in California. This is considered particularly relevant in areas with nearshore reefs where model assumptions (i.e., based on sandy seabed) are not met and biological protection issues are of particular concern. There also are concerns that factors such as bathymetry, slope, and hydrodynamics that occur off California are not adequately factored in existing models, which were developed to address transport under east and/or gulf coast conditions (D. Cannon, 2007 personal communication).

Routine monitoring of beach profiles in littoral cells where beach nourishment is planned and/or has been implemented would be useful for developing long-term data sets that may be used in the near-term to validate and improve performance of existing sediment fate-and-transport models using local environmental and physical conditions. Over the long-term, use of beach profiles, local wave data, and seafloor mapping would be useful for developing models more specific to environmental conditions unique to Calfornia.

Biological resource questions that would benefit from improved model prediction performance include:

- Post project sand thickness increase and persistence in areas with sensitive reef and/or SAV habitats (e.g., SANDAG and USDN 2000, CRM 2000, USACE 2005).
- Potential shoaling rates and potential alteration of maintenance dredge frequency of downstream inlets.
- Germano and Cary (2005) consider model refinement to quantify the extent and timing of mixing along the sediment-water interface essential to quantitatively defining biological impacts of dredged-induced sedimentation.

- Germano and Cary (2005) also reviewed that the dynamic energy budget (DEB) model is very useful for specific predictions of impacts and how to link individual effects to population responses, but the models require detailed laboratory results on response of specific organisms to sedimentation.

## *8.3 Regional Management of Cumulative Impacts and Ecosystem Benefits*

### *8.3.1 Expand Regional Databases and GIS Tools to Facilitate Protection of Biological Resources and Management of Cumulative Impacts*

Available studies indicate that cumulative impact detection requires a comprehensive analysis approach. Geographic Information Systems (GIS) have been used to map and overlay fishery resource areas and fishery patterns to support cumulative impact analyses of marine aggregate extraction areas and to more quantitatively assess the potential for impacts from future dredging licenses (Cooper 2005). GIS also has been used to assess the regional sensitivity of fisheries to human impact (Stocks et al. 2001 cited in Cooper 2005). Given that sediment management activities associated with beach nourishment affect broad geographic littoral cells, it makes sense to examine the potential for cumulative impacts from sediment management on a regional scale.

#### 8.3.1.1 Regional Biological Resource Database

It is recommended that regional GIS tools be developed that include mapping of nearshore, sensitive biological resources (including seasonal differences) and fishery resources within the depth range at potential risk to impacts from sediment management activities. These layers would complement the GIS database being developed by the CSMW and facilitate optimizing locations of beach nourishment based on environmental concerns and opportunities.

#### 8.3.1.2 Regional Cumulative Projects Database

It is recommended that regional planning agencies (e.g., SANDAG, BEACON) compile a master list of planned and foreseeable future coastal projects from coastal municipalities within their sphere of influence to facilitate cumulative impact assessments. Relevant information to include on the list include: project location, project size, oincludes littoral cell compile their coastal project lists on a bi-annual basis An information tool that would be beneficial to support cumulative impact analysis.

### *8.3.2 Minimize Multi-Use Cumulative Impacts*

Beach grooming is not a direct activity associated with beach nourishment. However, beach grooming may be undertaken at beaches that receive direct and/or indirect nourishment. Therefore, beach grooming may be indirectly related to sediment management activities that put sand on the beach.

Beach grooming has been demonstrated to impact grunion egg viability and reduce wrack associated forage for shorebirds. Beach maintenance best management practices to protect sensitive grunion habitat have been developed and workshop outreach has been conducted since in 2003 with resource and beach managers. Beach management practices are discussed particularly as they concern sharing the shoreline with humans and wildlife, including avoidance of grunion spawning habitat and minimizing disturbance of the wrack line that provides foraging opportunities for shorebirds such as the threatened snowy plover. Guidance implementation is voluntary and has been adopted by several municipalities from Santa Barbara to San Diego (K. Martin, 2007 personal communication).

It is recommended that CSMW formally recognize and assist this voluntary effort by including beach maintenance BMPs as an information topic on their website, including a link to www.grunion.org. In addition, beach maintenance guidelines should be incorporated into project level planning where beach nourishment is conducted.

### *8.3.4 Incorporate Ecosystem Benefits into Regional Sediment Management Planning*

Regional sediment management (RSM) planning is being conducted by the CSMW to facilitate decision making relative to matching sediment sources to areas of need based on consideration of a variety of factors. The following recommendations are made relative to RSM planning, as follows:

- Incorporate environmental constraints into RSM planning.
- Conduct RSM planning on a littoral cell basis.
- Address cumulative impact concerns on a littoral cell basis.

It is recommended that biological constraints information be compiled for each littoral cell according to sediment management needs. A standardized checklist should be developed to summarize sensitive biological resources within specified distance categories (e.g., within 1,000 feet, 2,000 ft, 1 mile, 2 miles) from historic and candidate beach nourishment sites (e.g., erosion hot spots). The checklist should consider other planning level environmental constraint checklists (e.g., SCOUP) and include identification of environmental issues such as erosion that may place sensitive habitats at risk, habitat degradation, and/or restoration need. Relevant geo-referenced point and/or coverage data on sensitive habitats and species also should be compiled as available for inclusion in GIS, with priority given to data that exhibits limited annual variability.

Conducting RSM planning on a littoral cell basis may facilitate optimization of beach nourishment design (locations, volumes) by consideration of sediment transport budget, locations of erosion hot spots, and locations of environmental constraints. In addition, planning on a littoral cell basis may improve evaluations and effectiveness of planning measures to minimize potential cumulative impacts associated with multiple uses of the coastal zone. This step has the potential to provide an important feedback-loop for appropriate environmental design of sediment management projects to meet shoreline protection needs while protecting biological resources. An important aspect of environmental design and cumulative impact analysis is public recreational use patterns and beach

management practices. Biological resource use patterns, particularly shorebirds, are influenced by recreational use.

### *8.3.5 Documentation of Environmental Benefits*

Beach nourishment often is the result of beneficial reuse of dredged material and may become an increasing beneficial use of sediment associated with coastal development as implementation of opportunistic sand programs (e.g., SCOUP) become more common. The term beneficial use in this context simply means use of the resource in productive ways (http://el.erdc.usace.army.mil/dots/budm/intro.cfm?Topic=Sediment).

Limited available information indicates that beach nourishment, if appropriately applied, may provide beneficial ecosystem functions. Sandy beaches provide habitat for marine invertebrates, which serve as prey for foraging shorebirds and nearshore fish. In addition, beaches provide important resting habitat for migratory shorebirds and far-ranging seabirds. Furthermore, they serve as spawning habitat for managed fishery species such as the California grunion. These habitat functions may become severely limited or eliminated at beaches subject to sand deficit and erosion. A recent study suggests that that these habitat functions were improved at erosive beaches after beach nourishment. Furthermore, limited available information suggests that adverse biological effects may be minimized when beach nourishment projects use are appropriately designed and implemented. Dissimilarities in substrate characteristics from native beaches and/or unfavorable seasonal timing distinguish projects where more pronounced adverse impacts have been reported.

Funding beach nourishment projects provides the opportunity to achieve multiple benefits that include environmental considerations besides the more commonly understood benefits to recreation, protection of property, public safety, and local economies. However, a more substantial body of biological monitoring is needed to better understand how to optimize the design of beach nourishment projects to satisfy both engineering and environmental objectives. Most monitoring programs have focused on documentation of sand transport and beach width performance or evaluations of adverse biological impacts and recovery. Little to no emphasis has been placed on monitoring biological resources to provide information to improve project design relative to resource protection and environmental benefits. It is recommended that a more balanced approach to monitoring be factored into funding allocations to provide information necessary for effective multi-benefit design of future beach nourishment projects.

It also is recommended that ecosystem benefits be included in cost-benefit ratio formulations to help ensure that the environmentally preferred alternative is the most ecologically sound in protecting California coastal biota.