Standard Operating Procedures (4.1): Fish Beach Seine

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Prepared for the United States Environmental Protection Agency

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Standard Operating Procedures:
Fish Beach Seine

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Protocol Suitability Evaluation

A habitat suitability table containing appropriate estuarine wetland habitat types (of those evaluated) to implement the fish beach seine protocol is displayed in Table 1. Small seines may also be appropriate in emergent salt marsh, but they are difficult to implement with vegetation present. A comparative assessment of cost, effort, and data quality are shown in Table 2. A matrix of additional detailed categorical evaluations of the fish beach seine protocol can be found in Appendix 4.1A.

Table 1. Appropriate habitat types for fish beach seine survey protocols.

	Habitat Types					
Survey Protocol	**Tidal Channel**	**Mud/sand flat**	**Emergent salt marsh**	**Non-tidal salt marsh**	**Salt pan**	**'Degraded' / fill**
Fish Beach Seine	X	X				

Table 2. Categorical assessment of cost/effort and data quality for fish beach seine survey protocols.

	Evaluation Metric	Fish Beach Seine	Notes
Time / Effort	Office Preparation Time	30-60 minutes	Gather equipment, site selection
	Equipment Construction Time (one time)	> 60 minutes	Build the seine and blocking nets (unless already put together), including placing weights and floats and tying to posts
	Field Time (per station)	> 60 minutes	Depending on the number of fish and size of the station, each station may take 1-3 hours
	Laboratory Time (per station)	0 minutes	Not applicable, unless post quality control checks on species identifications are necessary
	Post-Survey Processing / QAQC Time	10-30 minutes	----
	Minimum Repetition (site-dependent)	Few Repetitions	As fish are highly mobile and variable, repetitions are encouraged but are often time/effort limited
	Relative Cost (equipment and supplies)	> $1,000	Seines and blocking nets (may be expensive); wheelbarrow or other transportation
Survey / Data Quality	Accuracy (at a survey area level)	Medium	----
	Precision (at a survey area level)	Medium	Somewhat species-dependent; less effective for benthic species
	Qualitative-Quantitative Score	Quantitative	----
	Subjectivity-Objectivity Score	Objective	----

Resulting Data Types

The application of the fish beach seine survey protocol will yield quantitative data displayed as abundances by species or size frequency distributions across multiple time scales (e.g., seasonally, annually). These data are useful to identify the potential fish species composition / richness of particular wetlands, sub-areas, or habitats and to potentially identify the uses or functions of a particular wetland area by specific fish species (e.g., nursery). Data can be displayed as size frequency or abundance graphs, species presence tables, or at a higher-level using diversity indices. These data can also be used for multivariate community composition analyses. This survey protocol may also provide quantitative data on larger nektonic or demersal macroinvertebrate species such as shrimp or crabs (individuals must be larger than the net size to be captured).

Objective

Defining the fish assemblage of a wetland can be difficult, due to the highly mobile nature of the fauna. Fish are often among the first organisms to rapidly colonize restored habitats (Zedler 2001, Johnston et al. 2011). Wetlands act as nursery habitat for commercially and recreationally important species such as halibut (Beck et al. 2001), and are an assessable component of food web complexity, vertebrate diversity, overarching water quality conditions, and/or anthropogenic stressors (WRP 2006). For example, indicator fish such as the federally endangered tidewater goby prefer tidally restricted or calmer, brackish conditions (Swenson 1997).

The primary purpose of this sampling method is to quantitatively assess the distribution, relative abundances, species richness, and diversity of fish in intertidal wetland habitats using beach seines. While each type of fish sampling equipment (e.g., seines, trawls, enclosure traps, etc.) exhibits some degree of preferential capture or limitations to specific fauna, beach seines are generally appropriate for shallow, slow-moving water in tide channels or the equivalent habitat. As such, the geometry of the site (channel width) and tides should be the central factor in planning these surveys. Another goal of this SOP is to use a consistent method to develop quantitative, transferrable data for California wetland fish. Monitoring methods have consistently used beach seines to quantify fish abundances, but studies such as Steele et al. (2006) have shown that slight variations in sampling protocols can create substantial differences; therefore, consistent methods between survey programs are essential. Additional survey methods may be employed to assess broader fish species richness or targeted species, including Gobiidae or highly mobile species.

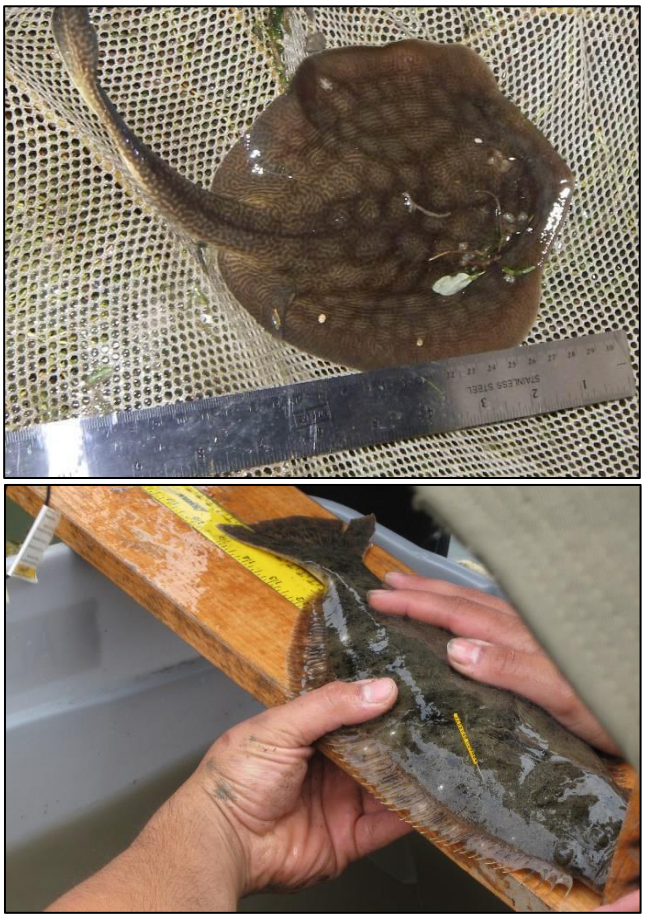

Figure 1. Round stingray being measured with a fish ruler (top), halibut being measured by fish measuring board (bottom).

Equipment

Equipment and supplies needed for this survey include:

1. GPS and extra batteries
2. Rulers or fish measuring board (Figure 1)
3. Fish seine net (1.8 m depth by 6 m width with 3.2 mm mesh delta style knotless nylon netting); must have floats at the top and a lead line at the base
    a. Note: size of the net can be varied if needed for additional depth or if the goal is to catch smaller fish; abundance data

from monitoring programs with different sized mesh may not be transferrable.

4. Two blocking nets (1.8 m depth by longer than the width of longest channel); must have floats at the top and a lead line at the base. The length of the net should be at least a few meters longer than the longest channel to be surveyed due to bowing from tidal currents and extra net to secure at the ends.
   Helpful hint: Larger nets are more difficult, logistically, for access and mobility to stations. If possible, a small wagon or dual-wheel wheelbarrow is recommended for transport.
5. Wetsuit (optional) or chest waders (if water is < 1.2 m)
6. Neoprene dive/surf booties and gloves
7. Aquarium nets (at least two, more are preferable)
8. Buckets and plastic containers (2-4 large buckets are recommended, with multiple other containers of varying sizes)
9. Camera and extra batteries or phone with camera application
10. Ice or MS22 if these are required for Institutional Animal Care and Use Committee (IACUC) or similar fish handling protocols
11. Scale (optional) Note: weighing of fish can be quite time consuming, may result in additional mortality and can be calculated fairly accurately using standard length; alternately, a subset of fish may be weighed, and the data extrapolated.
12. Datasheets (Appendix 4.1B)
13. Tarp (optional for protection of the transport vehicle) and to lay out at a station, if desired
14. Pliers or wire clippers for handling stingrays or spined fish

Helpful hint: If night fishing is part of the project or site monitoring goal, additional equipment will be necessary, including flashlights, headlamps, lanterns, and/or glowsticks.

Field Preparation

Site selection for fishing stations should follow guidelines developed for the SONGS Wetland Monitoring Program (CCC 2006). Many programs throughout California follow those guidelines, which were based on protocols developed by Dr. Joy Zedler. These guidelines recommend sampling multiple stations per estuary (e.g., 10 for a large wetland, fewer for a smaller site) spaced a minimum of 100 m apart to decrease chances for spatial autocorrelation. The stations should cover the range of tidal conditions of the estuary (e.g., creeks, channels, and/or basins). For extremely wide channels or basins, a separate field deployment configuration for the nets is recommended. Mouths of tidal channels may be challenging when experiencing higher tidal flows, due to the dragging of the nets.

Equipment described above should be collected prior to the field shift. Batteries for all electronic devices should be checked and replaced as needed, and relevant data sheets should be printed and attached to the clipboards. *Helpful hint: Waterproof paper can help reduce potential damage to field data sheets, though it is more expensive.*

Field Methods

June and September are recommended as the targeted survey months to coincide with peak fish abundances, but additional survey times (e.g., March or December) may be added by individual site needs or if additional time may be allocated (Zedler 2001). Sampling should not be conducted within 72 hours of a rain event due to the shift in freshwater conditions.

Station and seining protocols [recommended from SONGS Wetland Monitoring Program (CCC 2006)]:

1. Photograph each station before beginning (preferably with a GPS-enabled camera or smart phone from the center of the blocking nets facing across the channel).
2. For each station, position two blocking nets approximately six meters apart on the channel bank with the smaller seine in the middle. *Helpful hint: arrange the nets on the ground so upon deployment they will unfurl continuously from the bank without tangling. This may involve unrolling them prior to deployment and having one person at each net deploying the lead line.*
3. Deploy blocking nets (Alternative 1) (this configuration is recommended for small channels and creeks, or anything approximately < 30 m):
    a. Blocking nets should be deployed perpendicular to the shore and across the entire channel (Figure 2) to help prevent fish from escaping the survey area (Nordby and Zedler 1991, Steele et al. 2006, WRP 2006). Deploy both blocking nets slowly and simultaneously, at a rate of approximately one meter every few seconds (variable based on sediment composition). It is essential that the lead line (weighted line at the bottom of the net) remains in constant contact with the bottom substrate.
        i. Blocking nets can be deployed either by walking them across the channel or in a two-person kayak with one person paddling and the other facing backwards and unfurling the net from the back of the kayak.

Figure 2. Deployed blocking nets across a wetland channel.

b. After the blocking nets are deployed, walk back across the lead line to ensure consistent contact across the bottom of the channel, and check to make sure the float line is above the water surface.

4. Deploy blocking nets (Alternative 2) [this configuration is recommended for large (wide) channels or basins, or open water]:
    a. Blocking nets should be deployed with the person on each side walking straight out into the water approximately six meters (simultaneously), and then beginning to have each person who is deploying the blocking nets begin to walk towards each other until they intersect and overlap (Johnston et al. 2019, Figure 3). Deploy both blocking nets slowly and simultaneously, at a rate of approximately one meter every few seconds (variable based on sediment composition). It is essential that the lead line (weighted line at the bottom of the net) remains in constant contact with the bottom substrate. Once the blocking nets intersect, they should be joined such that there are no gaps between them for fish to escape.
        i. Someone should remain at the intersection of the nets to keep them joined (wrapping or holding the poles together is effective and pushing them into the sediment slightly) and to keep the lead lines pressed to the bottom.

Figure 3. Deployed blocking nets and walking out a fish seine across a large wetland channel (> 50 m).

5. Complete five replicate seine pulls across the channel (parallel to the shoreline for Alternative 1 or within the “triangle” of Alternative 2) in between the previously deployed blocking nets by

pulling the poles slowly and steadily with the lead line in constant contact with the substrate. Five replicates allow for most individual fish to be collected (Steele et al. 2006, CCC 2006).

a. Upon completion of each individual seine pull, bring the seine onto shore (lead line first with float line immediately following until the net is folded like a taco to prevent fish from escaping).
b. Place fish immediately into large buckets of water labeled with the seine number (i.e., 1-5). Take care to transfer the mid-water fish (e.g., topsmelt, anchovies) as quickly as possible to the buckets as these fish tend to be most susceptible to asphyxiation (Skinner et al. 1962). To avoid mortality, conduct counts of each seine immediately after completion, and some species may be counted and immediately released back into the channels. *Helpful hint: try to get the fish back in the water as soon as possible, especially mid-water fish, but do not release within or adjacent to deployed nets*.
c. Thoroughly search each seine multiple times. *Helpful hint: large chunks of algae can be discarded outside of the survey area after they are thoroughly searched for small or cryptic fish. This will allow the seine to be checked faster and with less repetitive effort*.

6. Retrieve the blocking nets (Figure 4) with nested, inward arcs and transfer those fish to buckets (see 5a-c). Maintain as close proximity as possible with the two sets of nets without overlapping. Tap the poles along the bottom and maintain lead line contact.

Figure 4. Retrieving blocking nets in a wetland channel.

Fish identification and measuring protocols:

1. Transfer fish immediately from the nets (Figure 5) into buckets filled with seawater to be measured and identified to species using fish field guides (Miller and Lea 1972, Allen et al. 2006). Appendix 4.1C is an abbreviated fish guide for southern California tidal marshes.

2. If there are fewer than 30 individuals of a species, all fish standard lengths (most anterior part of the upper or lower jaw to caudal peduncle) should be measured to the nearest millimeter (Merkel and Woodfield 2007, City of Los Angeles 2005, Figure 6). If more than 30 individuals of a given species are collected in each seine, there are two options for measuring (Alternative 1 and 2, below).
    a. Alternative 1: Only the first 30 "randomly" selected individuals of each species will be measured. The remaining fish of that species (> 30) should be counted and held for release in the buckets. This method is not preferred because there is no way to truly determine a random assortment of fish sizes. Grabbing fish at "random" can lead to selection of larger individuals. Small handheld nets swung around without looking into the buckets can assist in reducing selectiveness.
    b. Alternative 2: Measure every fish of a given species of interest (e.g., flatfish, special status species, warm water, or specialized species, etc.).

Figure 5. Searching though the pulled seine for fish transfer into buckets.

Figure 6. Measuring captured fish.

3. Fish that are too small (e.g., gobies ≤ 10 mm) to accurately identify in the field should be labeled as juveniles.
4. After being counted and measured, fish should be transferred to a release bucket (or released immediately – see seining protocol 5b).
5. Once a seine has been fully counted and measured, the fish may be released outside of the immediate station area (to avoid recapture). Repeat steps 1-5 for all five seines and the blocking nets.
6. (Optional) record macroinvertebrate catch data. Programs should be consistent in this level of data collection across surveys. Many wetland monitoring programs count and record macroinvertebrates of specific species such as crabs (e.g., *Cancer* spp., *Portunus* spp., etc.), invasive species (e.g., oriental shrimp, *Palaemon macrodactylus*), or other species of concern.
7. Complete the datasheet including start time, duration of survey, cloud cover, and precipitation (Appendix 4.1B).

Laboratory Methods

Not applicable.

Data Entry and QAQC Procedures

Data should be entered in the field using the appropriate data sheet (Appendix 4.1B). All required fields should be completed in full, and the data recorder should assign their name at the top of the document(s). Data should be transferred to the appropriate electronic database within three days, and the hard copies filed in labeled binders. Electronic copies of all data should be housed on an in-house

dedicated server and backed up to a cloud-based or off-site server nightly. Hard copies should be saved for five years. Electronic copies should be saved indefinitely.

Quality Assurance and Quality Control (QAQC) procedures should be conducted on all data. QAQC procedures should be conducted by the QA Officer and include a thorough review of all entries, double checking of all formulas or macros, and a confirmation that all data sheets, Chain-of-Custody forms, and field notes are filed appropriately with electronic back-up copies available. QAQC should verify that the entered data match the hard copies of the field data sheets. Any discrepancies should be corrected, and the initial data entry technician notified.

Data Analyses

After data have been entered, corrections made, and QAQC procedure completed, data can be used in multiple analyses. Examples include abundances by species (Figure 7), size frequency distributions, species presence or abundance by station or wetland, etc. If length-weight ratios are developed for individual species, then biomass estimates can be conducted.

Health and Safety Precautions

Care should be taken when handling species with spines (e.g., sculpin, stingrays) or sharp teeth (e.g., lizardfish). Additionally, appropriate attire and clothing should be worn for comfort and warmth in exposure to cold water for extended periods of time, e.g., wetsuit or waders (Figures 8 and 9). Bivalves or other invertebrates with sharp features can also be present in survey areas.

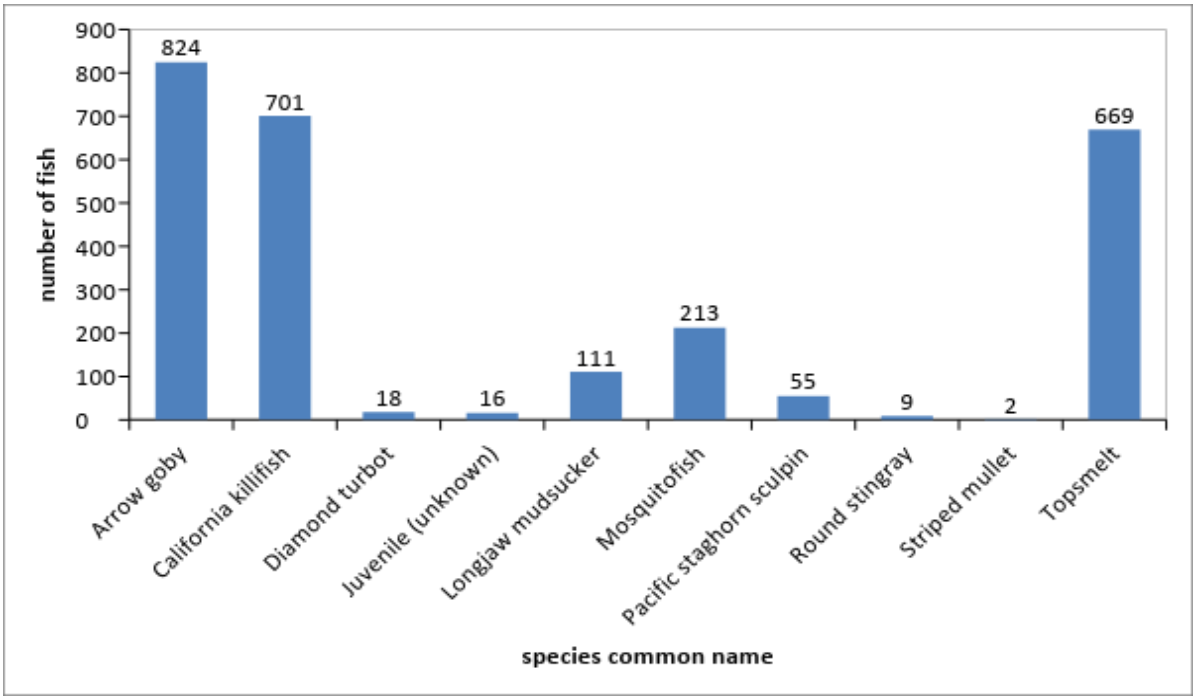

Figure 7. Total counts of each species of fish caught in the beach seine surveys across all stations (N = 6) throughout the first Baseline year (note: data are not intended for comparison, just reference to potential visualization type).

Figure 8. Photograph of fish seine being deployed at Malibu Lagoon.

Figure 9. Photograph of fish measuring board used to assess length of caught fish.

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Contact Information

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APPENDIX 4.1A

	Evaluation Metric	Fish Beach Seine	Notes
	Correlation to L2 CRAM	Attribute 2	Hydrology-dependent
Personnel Requirements	Specialty Equipment or Clothing Required	Many Specialty Items	Fish seines and blocking nets, aquarium nets, wetsuits
	Ease of Transport (amount or weight of supplies)	Many or Heavy Items / Difficult	See above (nets can be very heavy / bulky)
	Ease of Implementation	Difficult	Time consuming and a high level of coordination is required for successful implementation; field training is recommended
	Expertise / Skill Level	Some Technical Knowledge	Familiarity with species identifications is required
	Number of Personnel	> 3	----
	Training Requirements	None	----
	Seasonality of Survey Time	Spring and Fall	Both seasons are required to capture the breadth of fish activity and species diversity
	Suggested Frequency	Semi-annual	Or more frequent, project-dependent
Survey / Data Quality	Type of Output	Numerical	----
	Active or Passive Monitoring Style	Active	----
	Specialty Computer Software Required	No	----
	Availability of Online / External Resources	Many	----
Potential Limitations	Wetland Type Applicability	Bar-built and Estuarine	Must have tidal influence or prolonged water exposure
	Images or Multi-Media Required	Images Required	Photos are also helpful for species identifications
	Degree of Impact / Disturbance	High Disturbance	Walking and dragging nets through tidal channels will disturb sediments
	Vegetation Height Limitation	Not Applicable	----
	Appropriate for Tidal / Wet Habitats	Yes	----
	Tide Height	Medium to High Tide Only	Implementation within flood and ebb tides may be possible in full tidal environments
	Regional or Broad Implementation *	Almost Always Used	----
	Potential for Hazards / Risk	Medium Risk	----
	Restrictions	Special Status Species	----

** based on monitoring literature review*

APPENDIX 4.1B

FISH SAMPLING DATA SHEET

Sampling Program Information	
DATE:	GEAR:
STATION:	PAGE: __of__
STAFF:	
WEATHER:	

Rep	Start time / Stop time	Haul length
1	/	
2	/	
3	/	
4	/	
5	/	

#	REP	SPECIES	SL (mm)	WT (g)	#	REP	SPECIES	SL (mm)	WT (g)
1					36				
2					37				
3					38				
4					39				
5					40				
6					41				
7					42				
8					43				
9					44				
10					45				
11					46				
12					47				
13					48				
14					49				
15					50				
16					51				
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24					59				
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27					62				
28					63				
29					64				
30					65				
31					66				
32					67				
33					68				
34					69				
35					70				

**** measure first 30 of each species**

**** additional counts on back**

COMMENTS:

APPENDIX 4.1B

#	REP	SPECIES	SL (mm)	WT (g)
71				
72				
73				
74				
75				
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115				

#	REP	SPECIES	SL (mm)	WT (g)
116				
117				
118				
119				
120				

1.	**SPECIES:** ______________________		
2.	30 individuals measured?		(y / n)
3.	COUNT (> 30 but < 100)		(#)
4.	BATCH WT (> 30 but < 100)		(g)
5.	BATCH WT (remaining)		(g)

1.	**SPECIES:** ______________________		
2.	30 individuals measured?		(y / n)
3.	COUNT (> 30 but < 100)		(#)
4.	BATCH WT (> 30 but < 100)		(g)
5.	BATCH WT (remaining)		(g)

1.	**SPECIES:** ______________________		
2.	30 individuals measured?		(y / n)
3.	COUNT (> 30 but < 100)		(#)
4.	BATCH WT (> 30 but < 100)		(g)
5.	BATCH WT (remaining)		(g)

1.	**SPECIES:** ______________________		
2.	30 individuals measured?		(y / n)
3.	COUNT (> 30 but < 100)		(#)
4.	BATCH WT (> 30 but < 100)		(g)
5.	BATCH WT (remaining)		(g)

1.	**SPECIES:** ______________________		
2.	30 individuals measured?		(y / n)
3.	COUNT (> 30 but < 100)		(#)
4.	BATCH WT (> 30 but < 100)		(g)
5.	BATCH WT (remaining)		(g)

1.	**SPECIES:** ______________________		
2.	30 individuals measured?		(y / n)
3.	COUNT (> 30 but < 100)		(#)
4.	BATCH WT (> 30 but < 100)		(g)
5.	BATCH WT (remaining)		(g)

NOTES:

Appendix 4.1C

CLIO

Clevelandia ios

Arrow goby

Dorsal spines (total): 4 - 5; Dorsal soft rays (total): 15 - 17; Anal spines: 0; Anal soft rays: 14 - 17. Caudal rounded

FUPA

Fundulus parvipinnis

California killifish

Max 11cm; squarish tail fin; small pelvic fin, long anal w/ 11-13 rays: olive-green above, and a yellowish brown below

HYGU

Hypsopsetta guttulata

Diamond turbot

Max 46.0 cm; flattened/compressed body; triangular shape

PACA

Paralichthys californicus

California halibut

Max 152.0 cm; typically weighs 6 to 50 pounds (3 to 23 kg); flattened/compressed body; both eyes on one side of head

MUCE

Mugil cephalus

Striped mullet

bluish-gray/greenish above, silver along the sides, white on ventral surface; 6-7 black horizontal bars along sides; no lateral line; pectoral fins high on shoulders, pelvic fins abdominal

ATAF

Atherinops affinis

Topsmelt

silver, w/shiny silver lateral band; blue or green coloration dorsally; gills = golden-yellow; eyes small and beady; top lip folded down; long pelvic fins

GIMI

Gillichthys mirabilis

Longjaw mudsucker

Max 21.0 cm; first dorsal fin is relatively small, with 4-8 spines; second dorsal fin is larger, with 10-17 rays

GAAF

Gambusia affinis

Mosquitofish

small and stout, dull grey, robust fish with a rounded tail and a terminal and upward-pointing mouth

Appendix 4.1C

LEAR	ILGI	URHA	POLA
Leptocottus armatus	*Ilypnus gilberti*	*Urobatis halleri*	*Poecilia latipinna*
Pacific staghorn sculpin	**Cheekspot goby**	**Round stingray**	**Sailfin molly**
Max 46.0 cm, spines just anterior of gills, stripes on fins, slightly dorsally flattened	Max 6.4 cm; shadow spot anterior to pectoral fin	nearly round pectoral fin disc; brown or grayish above; pale yellow spots or reticulations; underside white to yellowish; tail short and stout, with a long, thick, serrated stinging spine	body oblong; head small and dorsally flattened, w/small, upturned mouth; caudal peduncle broad & large, rounded, and sometimes tipped with black