A Case Study Involving California's Latest Sediment Tool: Human Health Sediment Quality Objective Tier III Assessment

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Background: California SQOs

- 2009: Water Quality Control Plan for Enclosed Bays and Estuaries
  - Narrative Human Health Sediment Quality Objective (SQO)

- 2012: The TMDL for Greater Los Angeles and Long Beach Harbor Waters identified fish consumption impairments for PCB and DDX
  - Included SQO assessment compliance option

- 2018: Amendments to the 2009 Water Quality Control Plan
  - Provides process for Human Health SQO assessment

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Background – SQO Indirect Effects Assessment

- Three tiers of SQO Human Health Assessment proposed
- All tiers involve integration of: (1) chemical exposure; and (2) site sediment linkage

Tier	Description	Sediment Linkage
I	Screening, conservative assumptions	BSAF based on generic bioaccumulation model
II	Site assessment, more specific conditions	Some site-specific parameters, probabilistic framework
III	Refined assessment, more complex situations	Site-specific, calibrated model, deterministic framework

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The Challenges and Benefits of a Tier III Assessment

- Challenges
  - No policy written
  - Requires conversion of sediment contribution (determined by modeling) to Tier II categories
  - Cost

- Benefits
  - No policy written
  - The Ports asked by the California Water Quality Control Board to apply Tier III as the first case study prior to completion of State Policy

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Tier III Assessment – Steps

1. Develop a linked hydrodynamic, sediment-transport, fate (WRAP)-bioaccumulation model for the Greater Harbor Waters (including CSM, data collection, fish-tracking study, model calibration)

   – Peer review

2. Determine method for measuring sediment linkage

   – Get regulatory approval

     • Ongoing collaboration with State Water Board

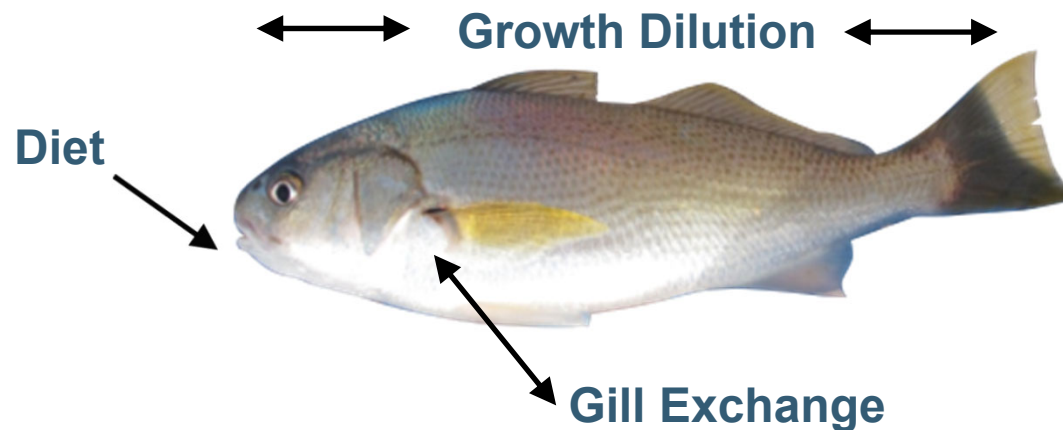3. Combine sediment linkage with chemical exposure data

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Tier III Assessment

Step 1 – Develop a Linked WRAP-Bioaccumulation Model

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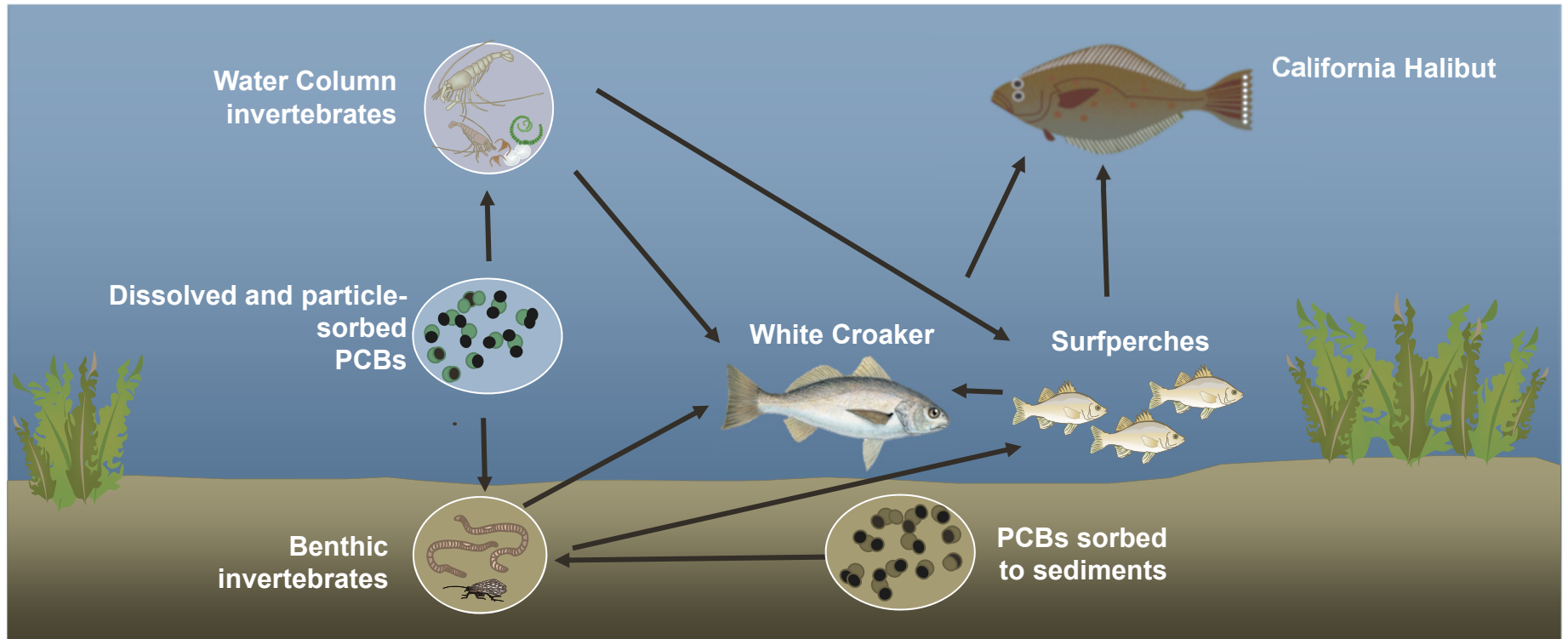
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Bioaccumulation Model Framework

- AQFDCHN
  - Bioenergetic, mechanistic, dynamic modeling framework
  - Developed by Thomann and Connolly in 1984
  - Accounts for complex food web structure and fish movement, in addition to site-specific growth rates and lipid contents

Growth Dilution

Diet

Gill Exchange

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Representative Harbor Food Web

Notes:
White croaker picture from Larry Allen
California halibut picture from http://www.selfridges.com/content/project-ocean-fish-guide

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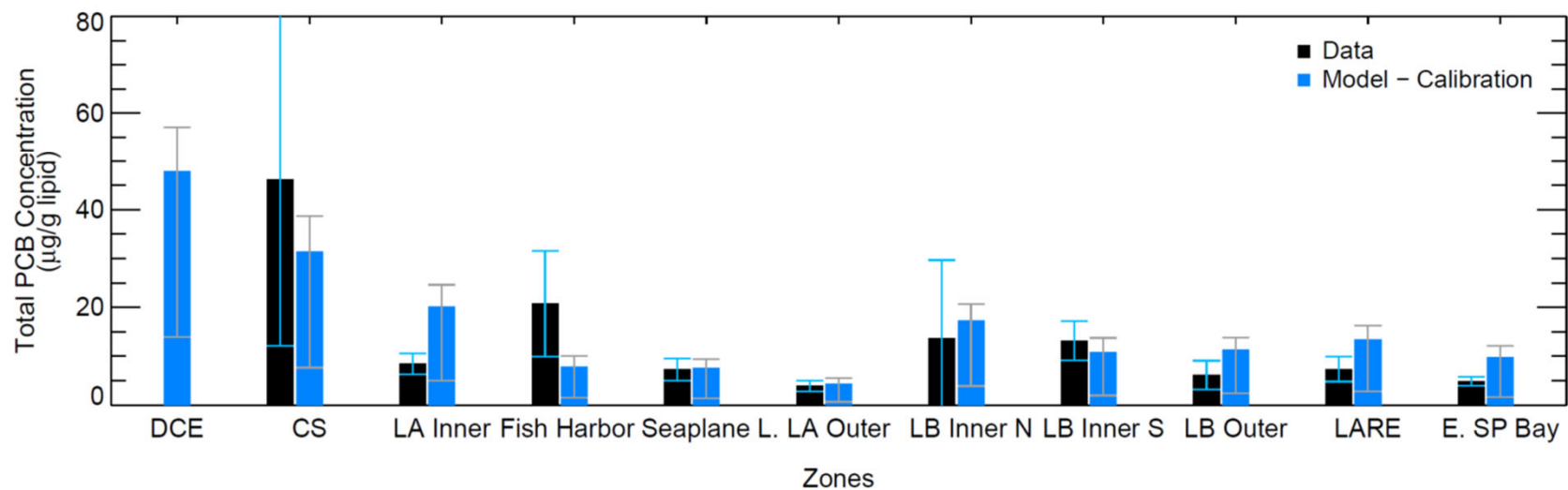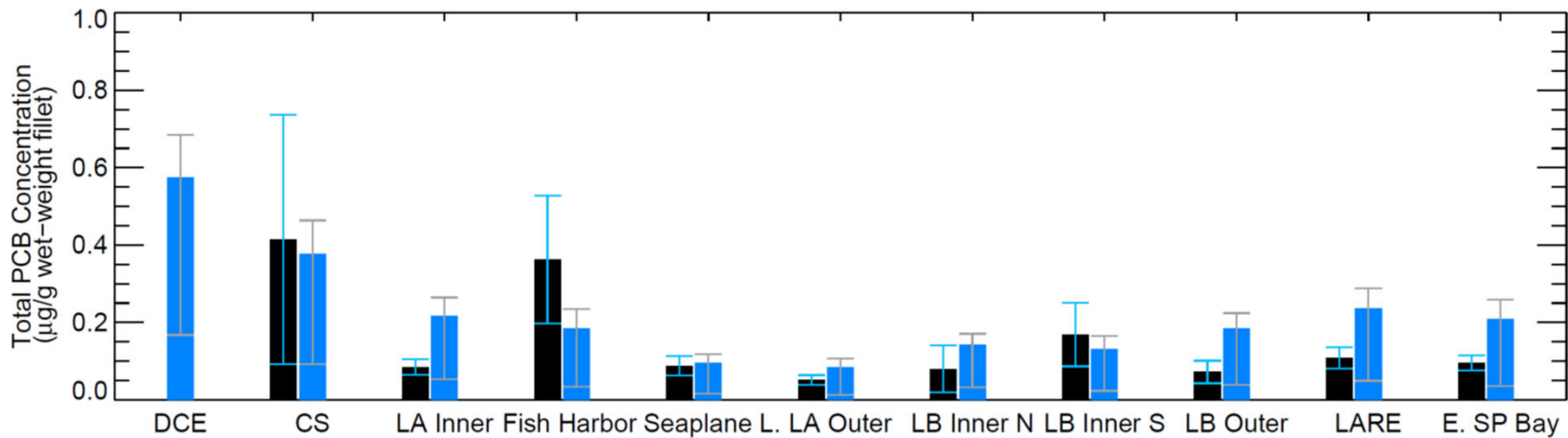
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Fish Movement Zones

- Fish subpopulations developed by grouping tagged fish with similar movement patterns

- Other considerations
  - Areas targeted for future management actions
  - Physical characteristics: depth, grain size, and TOC
  - Biological characteristics: benthic infaunal abundance

Fish Movement Zones*

Color	Zone
Dominguez Channel Estuary FMZ	Fish Harbor FMZ	LB Inner Harbor South FMZ
Consolidated Slip FMZ	Seaplane Lagoon FMZ	LB Outer Harbor FMZ
LA Inner Harbor FMZ	LA Outer Harbor FMZ	Los Angeles River Estuary FMZ
	LB Inner Harbor North FMZ	Eastern San Pedro Bay FMZ
		Outside Harbor Exposure Area

*Fish movement zones are not necessarily equivalent to TMDL-designated waterbodies.

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Calibration: Example – White Croaker PCBs

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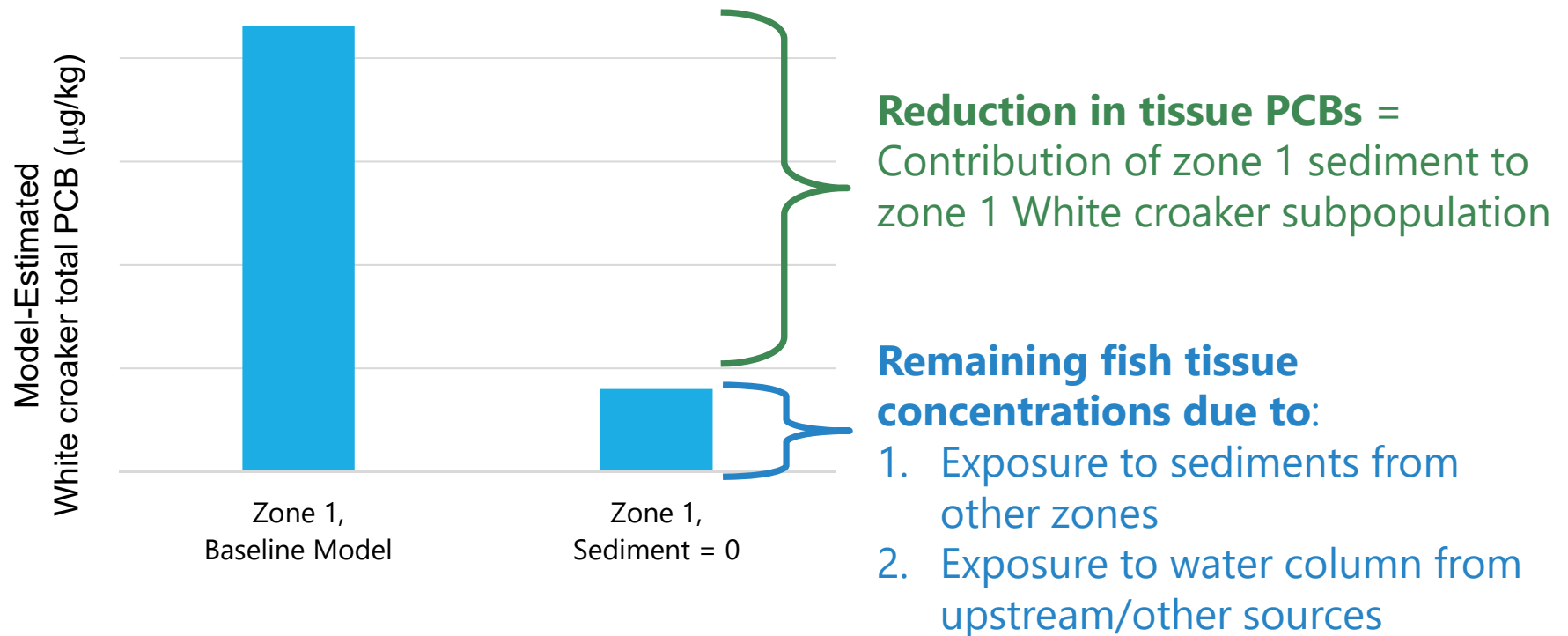
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Peer Review

- Panel included representation from public, private, and academic sectors

- Bioaccumulation model found to accurately simulate linkage between sediment, water, and fish PCB and DDX concentrations

- Peer review concluded the linked WRAP-bioaccumulation model would be an acceptable tool for evaluating sediment linkage
  - Following multiple interactions between panel, modelers, Ports, and regulators

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Tier III Assessment
Step 2 – Establish Approach for Sediment Linkage

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Sediment Contribution Determination

Model-Estimated White croaker total PCB (µg/kg)

Zone 1, Baseline Model

Zone 1, Sediment = 0

Reduction in tissue PCBs = Contribution of zone 1 sediment to zone 1 White croaker subpopulation

Remaining fish tissue concentrations due to:
1. Exposure to sediments from other zones
2. Exposure to water column from upstream/other sources

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Approach to Categorizing Results

- Three sediment contribution estimates for each zone: best estimate, upper and lower bound

- Distribution of model- estimated sediment linkages compiled for each zone and model species

- Categorize data into existing categories in SQO framework based on comparison to 50% sediment contribution threshold
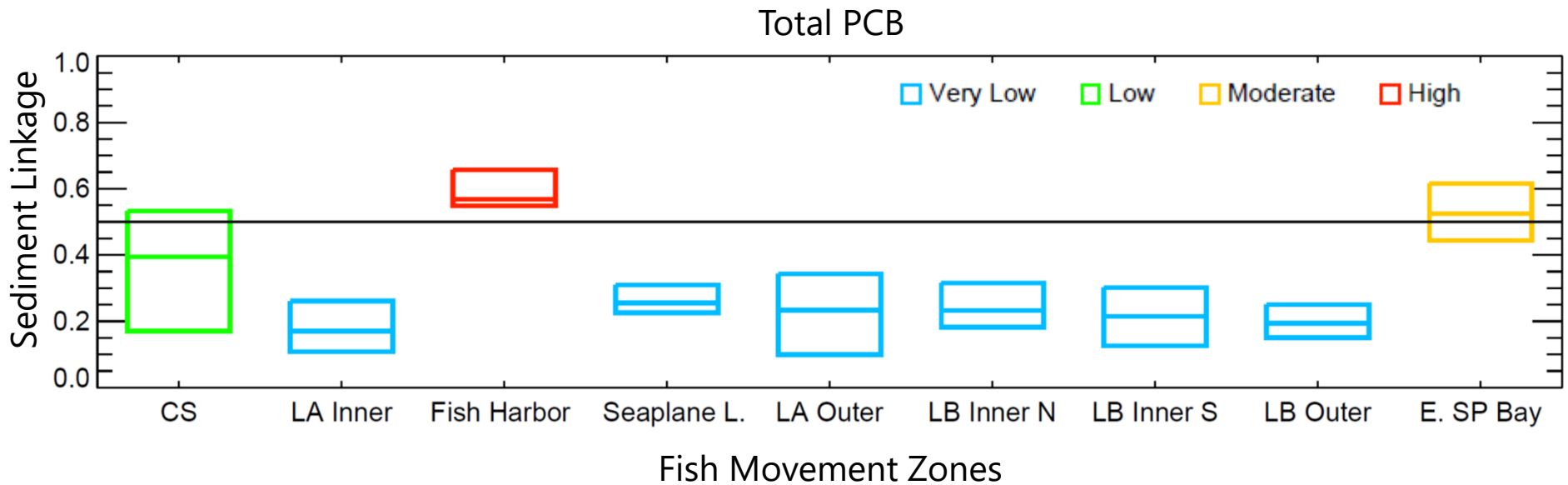
75%ile <50% = Very Low
50%ile <50% = Low
50%ile >50% = Moderate
25%ile >50% = High

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Market Basket Sediment Linkage – PCBs in Fish Movement Zones

Total PCB

75%ile <50% = Very Low
50%ile <50% = Low
50%ile >50% = Moderate
25%ile >50% = High

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Tier III Assessment

Step 3 – Combine sediment linkage with chemical exposure

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Integration with SQO Process – Final Indirect Effects Site Assessment

- Final Site Assessment based on both sediment contribution and consumption risk

		Consumption Risk				
		Very Low	**Low**	**Moderate**	**High**	**Very High**
Study Area Sediment Contribution	**Very Low**	Unimpacted	Unimpacted	Likely Unimpacted	Likely Unimpacted	Likely Unimpacted
	Low	Unimpacted	Unimpacted	Likely Unimpacted	Possibly Impacted	Likely Impacted
	Moderate	Unimpacted	Likely Unimpacted	Likely Impacted	Likely Impacted	Clearly Impacted
	High	Unimpacted	Likely Unimpacted	Likely Impacted	Clearly Impacted	Clearly Impacted

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Chemical Exposure Draft Results – PCBs

Chemical Exposure Categories	Market Basket PCBs (µg/kg)
< FCG (<3.6 µg/kg); Very Low	
< ATL3 (<21 µg/kg); Low	
< ATL2 (<42 µg/kg); Moderate	
< ATL1 (<120 µg/kg); High	
> ATL1 (>120 µg/kg); Very High	
Consolidated Slip	167.1
LA Inner Harbor	91.6
Fish Harbor	143.8
Seaplane Lagoon	57.4
LA Outer Harbor	27.5
LB Inner Harbor – North	53.2
LB Inner Harbor – South	76.9
LB Outer Harbor	34.8
Eastern San Pedro Bay	79.4

Notes:
Only fillet (croaker and halibut) or estimated fillet (surfperches) used
Fish data were collected between 2002 and 2016
ATL3/2/1: Advisory tissue levels 3/2/1 based on consumption of 3/2/1 meals per week
FCG: Fish Contaminant Goal

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Draft Integrated Tier III Site Assessment Results: Market Basket

Fish Movement Zone	Chemical Exposure	Site Sediment Linkage	Site Assessment
Consolidated Slip	Very High	Low	Likely Impacted
LA Inner Harbor	High	Very Low	Likely Unimpacted
Fish Harbor	Very High	High	Clearly Impacted
Seaplane Lagoon	High	Very Low	Likely Unimpacted
LA Outer Harbor	Moderate	Very Low	Likely Unimpacted
LB Inner Harbor – North	High	Very Low	Likely Unimpacted
LB Inner Harbor – South	High	Very Low	Likely Unimpacted
LB Outer Harbor	Moderate	Very Low	Likely Unimpacted
Eastern San Pedro Bay	High	Moderate	Likely Impacted

Summary of Tier III Assessment Case Study: Greater Harbor Waters

- Successful model development and peer review

- Good collaboration with regulators

- Process for determining sediment linkage established

- First Tier III assessment

- Case study contributed to development of new policy

- Assessment targets sediments based on fish exposure

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Questions/Discussion?