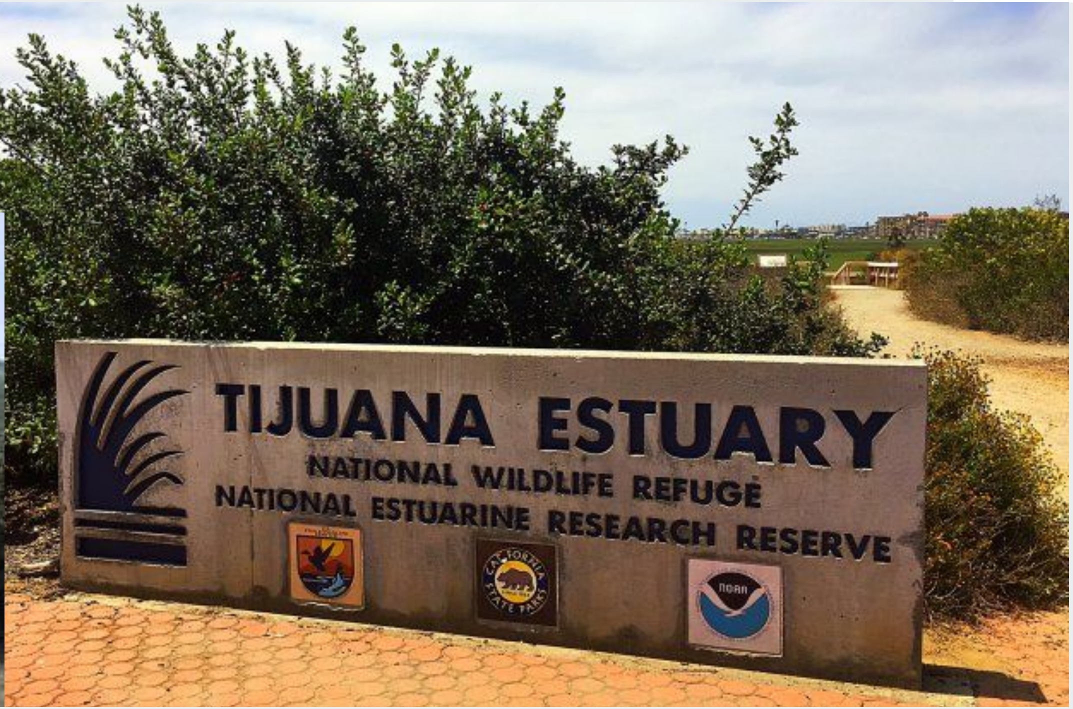
CSU COAST Internship: Tijuana River National Estuarine Research Reserve



About me: Melissa Belen-Gonzalez

- Undergraduate at San Diego State University
- Research Assistant of the LongLab (SDSU)
- SDSU IMSD Scholar
- Fish and crab lover

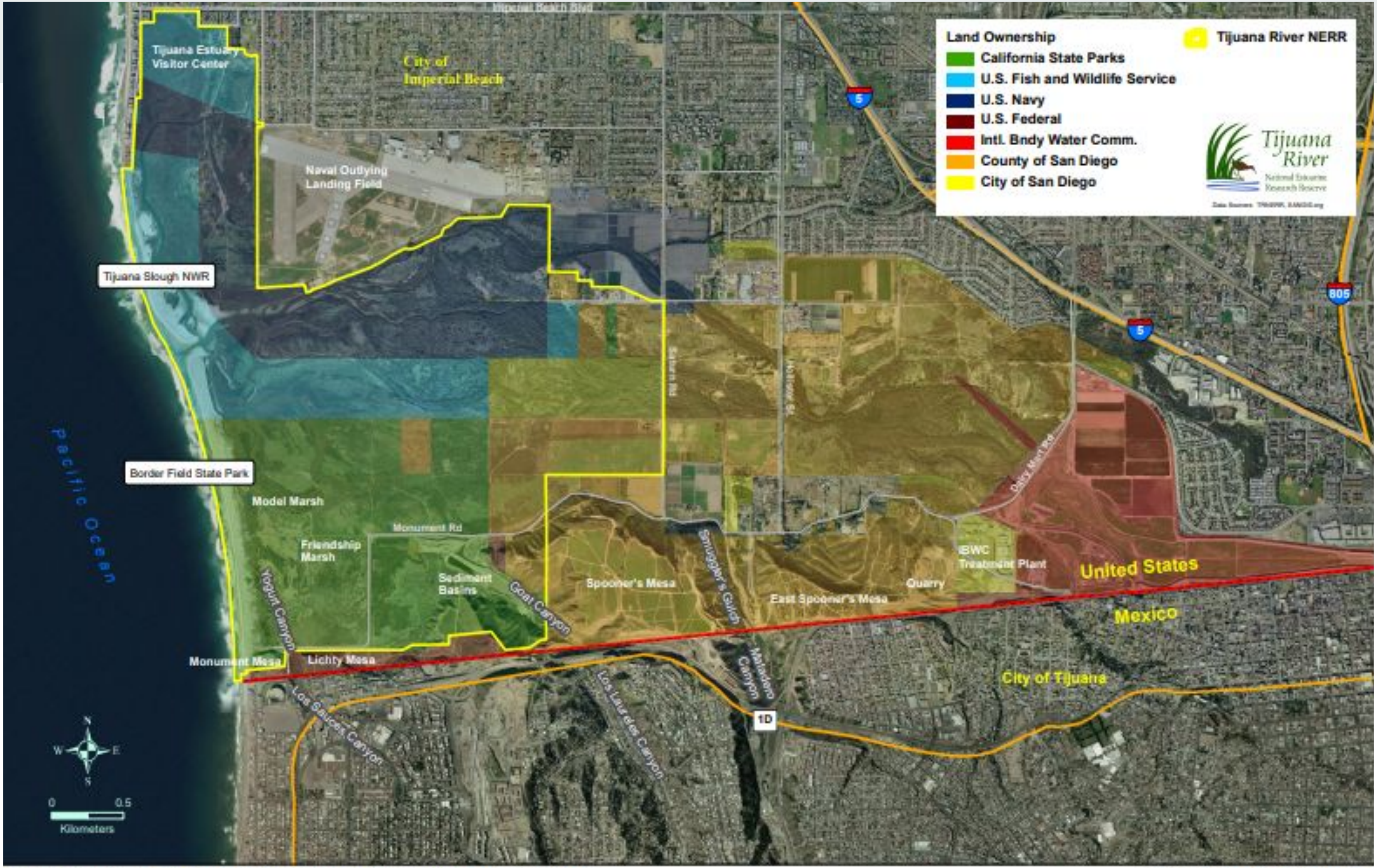
Let’s go fishing

- History of TRNERR & Ownership Map
- Background of Research
- Historical Methodology
- Results of Historical Data
- Future Factors to Consider
- Mini Activities
- Potential Future Collaboration

History of TRNERR pt.1

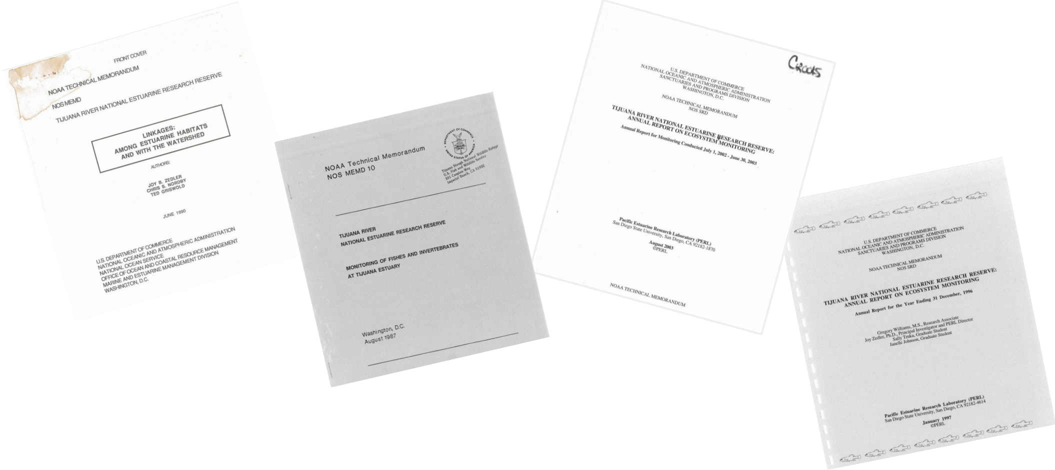
- 1851: International boundary between US and MX surveyed
- 1887 & 1889: City of Imperial Beach & Tijuana founded
- Early 1940s: Border Field Auxiliary Landing Field built on Southern side of Estuary
- 1944: US and MX sign treaty est. “Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande”
- 1983: Strong winter El Nino storms with extreme flooding, channel migration and sedimentation
- 1984: Spring mouth closure prevents tidal flushing causing hypersalinity conditions ; Mouth re-opened in December mechanically
- 1980-1990: Approx. 13 million gallons per day (MGD) of wastewater flow in the Tijuana River with chronic beach closures
- 1991: MX installs water diverter to treat 13 MGD but system overlflows and line breaks during heavy storm conditions
- 1993: Heavy spring storms causing flooding and 3MGD of sewage flows into the TJE
- 1995: Sewage flows an average of 1MGD
- 1997: South Bay International Wastewater Treatment Plan est. to treat excess wastewater flow and discharges in TJE
- March 2000: Sedimentation in TJE Northern Arm
- 2017: Major sewage spill affecting multiple SD beaches (30-230MGD reported, actual amount unknown)
- Major sewage spill and environmental education history

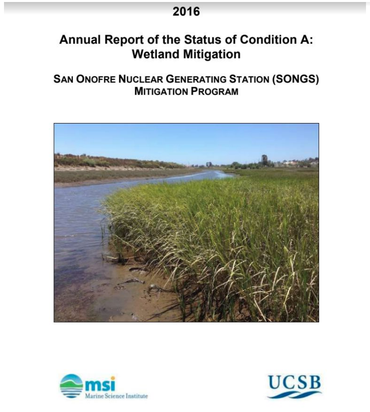
History of TRNERR pt.2

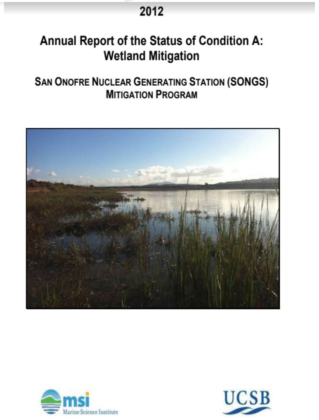


RESERVE BOUNDARY AND TIJUANA RIVER VALLEY OWNERSHIP

Background: Historical Annual Reports



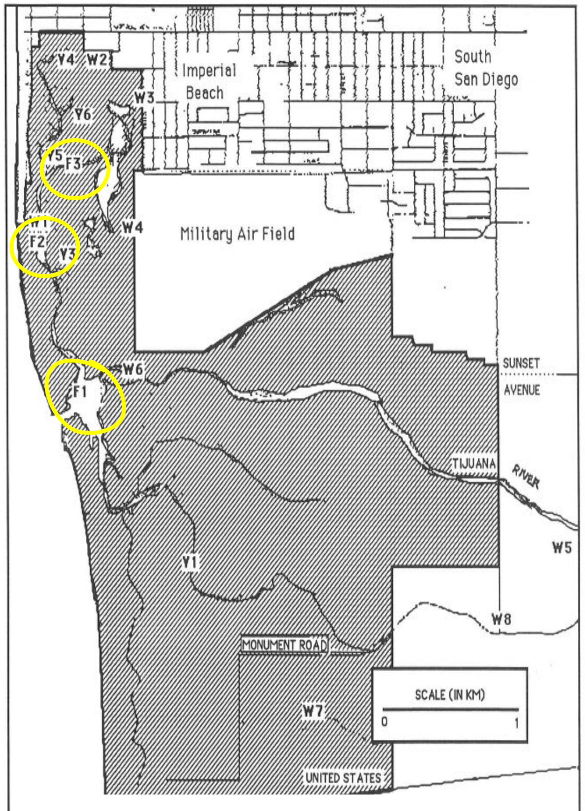




- From 1986 to 2003 the TRNERR had NOAA Annual Reports done by Joy Zedler, Chris Nordby, and Julie Desmond
- From 2004 to 2008 Annual Reports stopped being produced however Jeff Crooks continued fish sampling
- No fish sampling done for 2009-2012
- From 2013 to present day, in collaboration with SONGS fish sampling as continued

Background: Historical Sampling Sites pt.1

Figure 1. Sampling stations at Tijuana Estuary. F =Fish sampling stations (F1 = Mouth; F2 = Main North Channel or Oneonta Slough; F3 = East-West Channel). V = Vegetation sampling stations (V1 = Old River; V2 = Near Mouth; V3 = Tributary; V4 = Peninsula, V5 = East-West Channel; V6 = Original). W = Water quality sampling stations (W1 = Main North Channel = Oneonta Slough; W2 = 3rd & Caspian; W3 = 5th & Grove; W4 = Airport Runoff; W5 = Hollister Bridge; W6 = Mouth; W7 = Goat Canyon; W8 = Smuggler's Gulch).



TRNERR NOAA Annual Report Map 1986

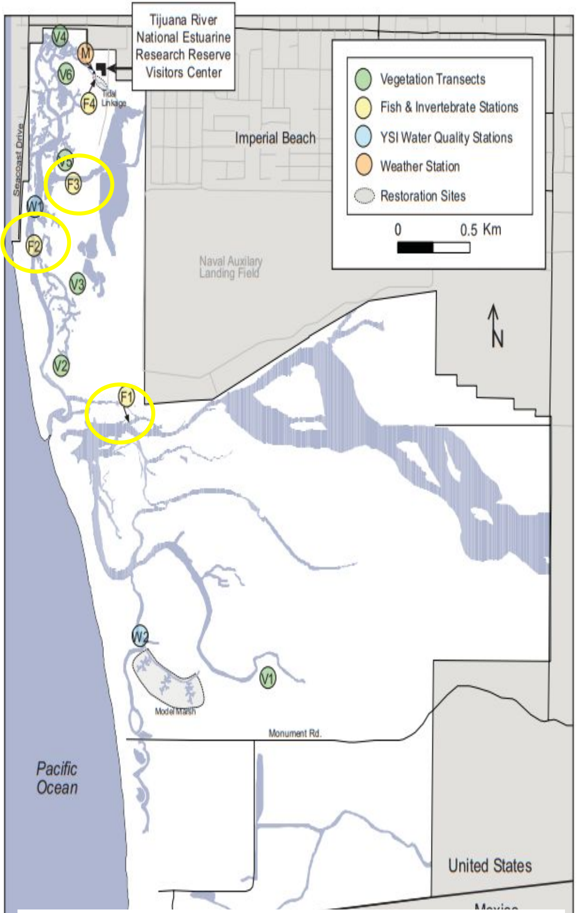
F1: Mouth Station
- Has the most direct exposure to freshwater and wastewater inflow from upstream
- Sand and mud substrate

F2: Oneonta Slough/ Main North Channel / Seacoast Station
- Located closest to ocean
- Highly influenced by marine conditions
- Sand substrate

F3: East-West Channel
- Connects inland ponds and mudflats to Oneonta Slough
- Transition habitat
- Clay and shell substrate

SONGS Map 2013-2017

Background: Historical Sampling Sites pt.2



TRNERR NOAA Annual Report Map 2003

SONGS Map 2013-2017

- All stations and majority of seasons were sampled quarterly (Spring, Summer, Fall, Winter) from 1986-1991 and 1993-2003
- Mouth Station stopped being sampled after 2008
- Missing season/station data caused by either flooding or lack of budget
- Only the Fall season was continuously sampled from 2013-2017 from Oneonta Slough and East-West Station
- The SONGS map depict the closest following stations of the historic Oneonta Slough and East-West Channel

Historical TRNERR Fish Sampling Methodology

Year	Seine	Passes	Collections
1986-1988	3mm mesh bag seine and two 3mm mesh blocking nets deployed at slack low tide. Blocking nets closed by sweeping in toward center of blocked area until fish. Seines hauled until number of fish per seine approached zero.	**???**	Quarterly
1989	Use of lower marsh was sampled with a 3mm mesh Flume net walls were 20m long, bottoms were 15-20cm and buried in sediment, netting stapled then tied to wooden posts 2-3m apart. Flume was 20m long, 1m high forming a chute. Cod end net was 1in PVC frame, 1m tall, and 1.25m wide connected to 3mm mesh conical bag. Monitoring done with a 3mm mesh blocking net and bag seine, same methods as previous years.	4-5	Quarterly
1990	3mm mesh bag seine, blocking nets, and channel nets.	4-5	Quarterly
1991	3mm mesh bag seine, blocking nets, and channel nets.	3	Quarterly
1992	3mm mesh bag seine and two 3mm mesh blocking nets No blocking net in October.	2-3	Biannually
1993	Mouth not sampled in March. 3mm mesh bag seine and two 3mm mesh blocking nets. No blocking net through June.	5 in Sep and Dec	Quarterly
1993-1997	3mm square delta mesh 13.3m x 2.1m bag seine and two blocking nets deployed at slack low neap tide.	**???**	Quarterly
1998-2002	3mm square delta mesh 13.3m x 2.1m bag seine and two blocking nets deployed at slack low neap tide.	3-5	Quarterly
2004-2008	3mm square delta mesh 13.3m x 2.1m bag seine and two blocking nets deployed at slack low neap tide.	3	Variable
2013-2017	**Seine Sampling:** 25ft seine net and blocking nets are used to, seines slightly overlap to close the area. A net drags through and is passed through a seawater-filled cart and removed. First ten fish of each species are measured for length and all identifiable organisms are counted. Unidentifiable organisms are taken back to the lab to be processed and identified. After each hall organisms are released outside the enclosed area. Each 5 passes is a completed haul. **Enclosure Sampling:** designed for burrowing gobies such as arrow, cheekspot, and shadow gobies, and invertebrates. Deployments are done at same locations as the beach seine samples. Five replicate enclosures are completed for every sampling station in which enclosures are gently thrown at ~3ft. Depth, algae, and vegetation percent cover are also measured. A BINCKE (folding net) extracts fish and inverts within enclosures to be identified, counted, then released outside the sampling area. First ten fish of each species are measured for length, inverts identified but not counted, and all unknown species are taken back to the lab and preserved for identification. Each BINCKE pass is a haul and the enclosure is complete once 3 hauls are pulled without trapping any fish.	5	Annually, 3 consecutive days in Fall (Sep or Oct)

Historical TRNERR Fish Sampling Methodology

Seine sampling (left) and enclosure sampling (bottom)

Results of Historic Data: 1930's

Species Common Name	Scientific Name	Quantity
DIamond flounder	*Hysopetta guttulats*	Many
Jordan flounder	*Eopsetta jordani*	Not many
Blenny ?	*Alticus atlanticus*	A few
Top Minnow	*Cyprinodontidae ?*	A few
Panzarotto (Topsmelt?)	*Atherinops* affinis littoralis	???
Arctic sculpin	*Artediellus uncinatus*	Not so many
Pipefish	*Syngnathus leptorhynchus*	Many
Sunfish (Sacramento perch)	*Archoplites interruptus*	Few
Pogies?	*Brevoortia ?*	Many
Yellowfin Croaker	*Umbrina roncador*	Mostly at mouth
Mullet	*Moxostoma ?*	Many

Results of Historic Data: 1971 and 1976

Table 9. Fishes and rays recorded from the Tijuana Estuary.

Organism	Source of data: Ford et al. 1971[a] Sites 1	2	3	IBWC 1976	White and Wunderlich Unpubl.	Nordby 1982 Larvae	Eggs
ATHERINIDAE (Silversides):							
Atherinops affinis - topsmelt	1	324	119	x[b]	A[c]	x[d]	x
BATRACHOIDIDAE (Toadfishes):							
Porichthys myriaster - specklefin midshipman				x	U		
BLENNIDAE (Combtooth blennies):							
Hypsoblennius gentilis - bay blenny	6	0	<1	x	C	x[d]	
BOTHIDAE (Lefteye flounders):							
Citharichthys spp. - sanddabs							x
Paralichthys californicus - California halibut	8	0	7	x	A	x	x
CLUPEIDAE (Herrings):							
Sardinops sagax caeruleus - Pacific sardine						x	x
COTTIDAE (Sculpins):							
Artedius harringtoni - scalyhead sculpin						x	
Leptocottus armatus - staghorn sculpin	11	12	14	x	A	x	
CYNOGLOSSIDAE (Tonguefishes):							
Symphurus atricauda - California tonguefish				x	U		x
CYPRINODONTIDAE (Killifishes):							
Fundulus parvipinnis - Caifornia killifish	29	692	3	x	A	x	
DASYATIDIDAE (Stingrays):							
Urolopus halleri - round stingray				x	U		
EMBIOTOCIDAE (Surfperches):							
Amphistichus argenteus - barred surfperch	32	25	30	x	U		
Cymatogaster aggregata - shiner perch				x	U		
Hyperprosopon argenteum - walleys surfperch				x	U		

(continued)

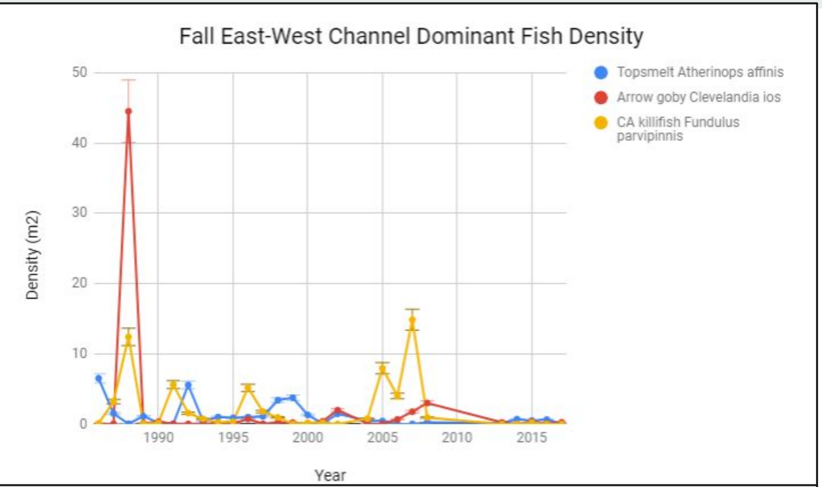
Table 9. *(Concluded)*.

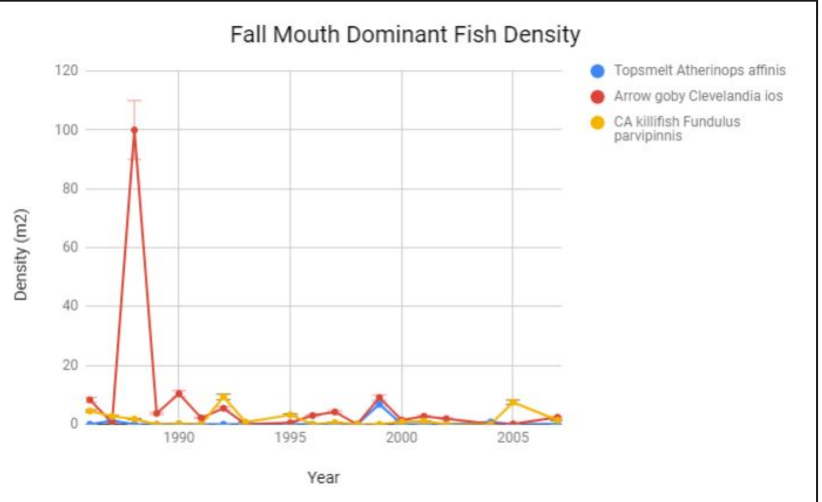
Organism	Source of data: Ford et al. 1971[a] Sites 1	2	3	IBWC 1976	White and Wunderlich Unpubl.	Nordby 1982 Larvae	Eggs
ENGRAULIDAE (Anchovies):							
Anchoa compressa - deepbody anchovy					C		
Anchoa delicatissima - slough anchovy	0	4	<1	x	C		x
Engraulis mordax - northern anchovy						x	x
GOBIIDAE (Gobies):							
Clevelandia ios - arrow goby	245	1,896	15	x	C	x[d]	
Gillichthys mirabilis - longjaw mudsucker				x	C	x	
Ilypnus gilberti - cheekspot goby	534	0	32	x	C	x[d]	
Quietula y-cauda - shadow goby	29	0	0	x	C	x[d]	
KYPHOSIDAE (Sea chubs):							
Girella nigricans - opaleye	31	44	<1	x	C	x	
LABRIDAE (Wrasses):							
Semicossyphyus pulcher - California sheephead							x
MUGILIDAE (Mullets):							
Mugil cephalus - striped mullet				x	A		
MYLIOBATIDAE (Bat rays):							
Myliobatus californicus - bat ray				x	R		
OPHIDIIDAE (Cusk-eels):							
Otophidium scrippsi - basketweave cusk-eel							x
PLEURONECTIDAE (Righteye flounders):							
Hypsopsetta guttulata - diamond turbot	47	0	16	x	A	x	x
Pleuronichthys coenosus - C-O turbot							x
Pleuronichthys ritteri - spotted turbot				x	A	x	x
Pleuronichthys verticalis - hornyhead turbot						x	x
RHINOBATIDAE (Guitarfishes):							
Rhinobatus productus - shovelnose guitarfish				x	R		
SCIAENIDAE (Croakers):							
Genyonemus lineatus - white croaker				x	U	x	x[d]
Menticirrhus undulatus - California corbina				x	U	x	x[d]
Seriphus politus - queenfish						x	x[d]
SCOMBRIDAE (Mackerels):							
Scomber japonicus - Pacific mackerel						x	x
SERRANIDAE (Sea basses):							
Paralabrax clathratus - kelp bass				x	U		
Paralabrax maculatofasciatus - spotted sandbass				x	C		
Paralabrax nebulifer - barred sandbass	5	0	<1	x	C		
SPHYRAENIDAE (Barracudas):							
Sphyraena argentea - California barracuda						x	x
SYNGNATHIDAE (Pipefishes and Seahorses):							
Syngnathus leptorhynchus - bay pipefish				x	U	x	

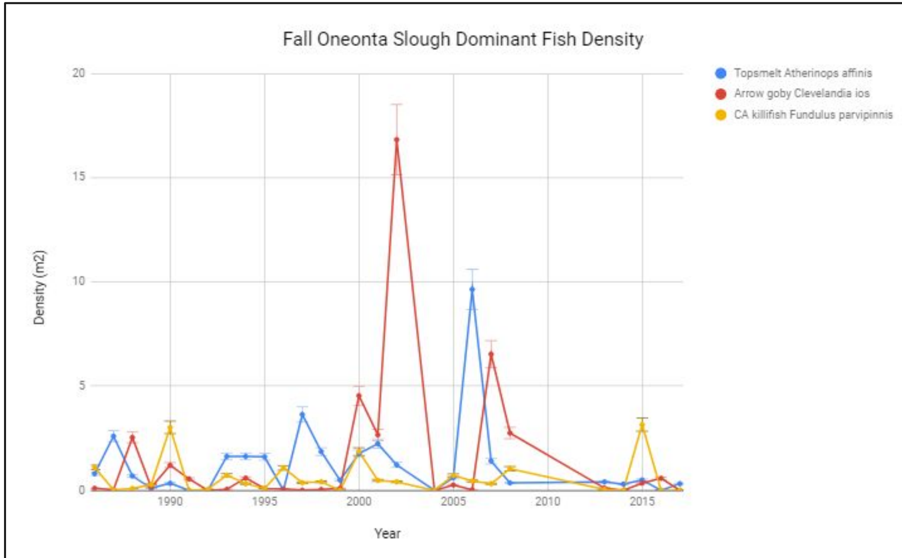
[a]numbers = individuals/500m^2
[b]x = species present
[c]A = abundant, C = common, U = uncommon, R = rare
[d]The larvae or eggs of these species could not be identified to the species level. It is likely that the species are represented, however.

Results: Preliminary Univariate Data

Originally the Fall season was being analyzed since it had the most complete season for 2 of the 3 stations. The graphs below depict the preliminary data of the 3 most dominant fish species within the TJE

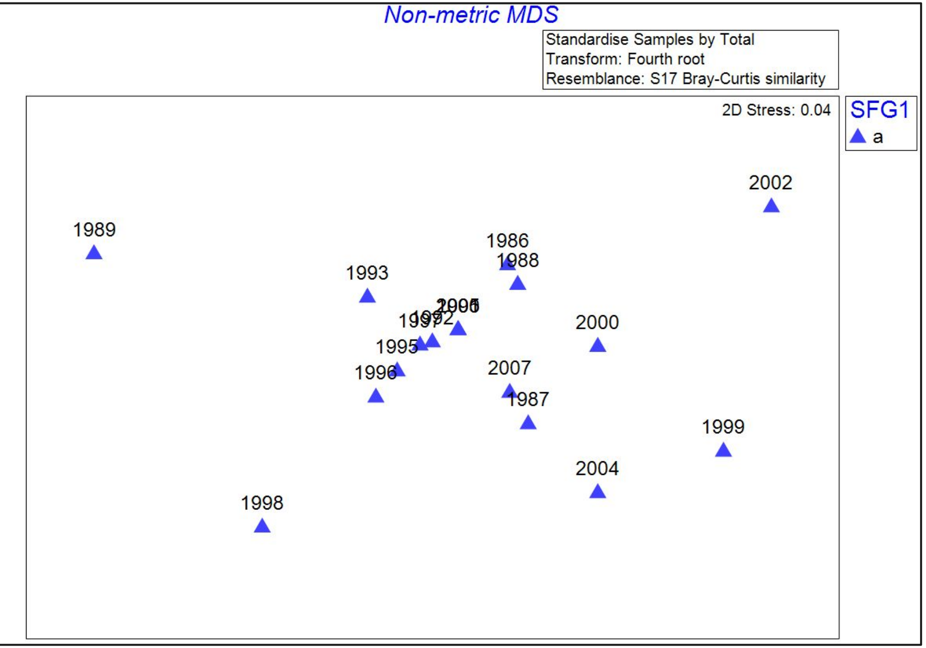




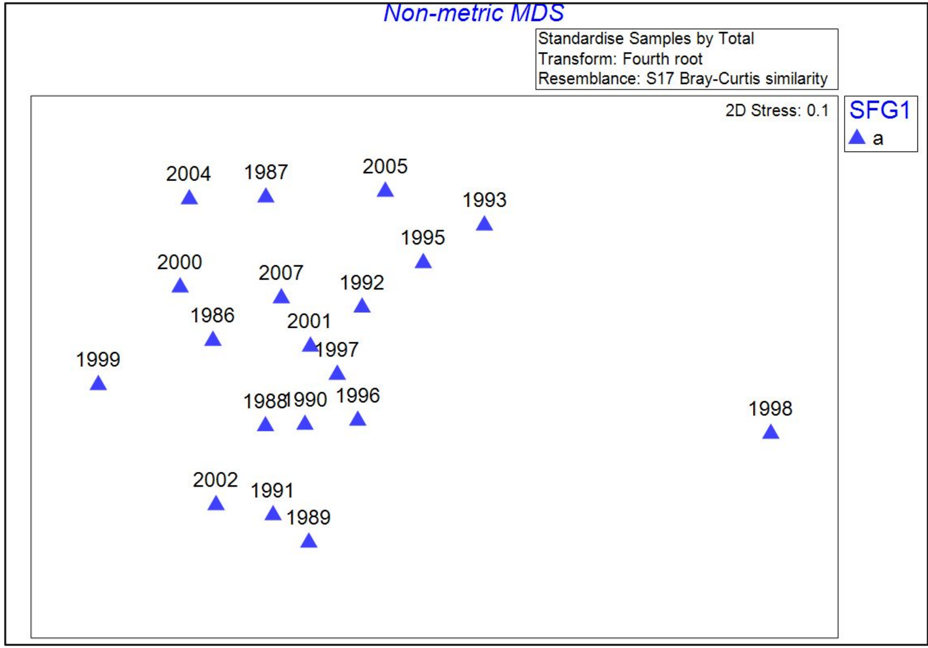


Comparing multivariate Fall data: Mouth Station

Mouth Station had the least amount of years sampled and there were no obvious differences with or without larger gobies sampled by enclosures

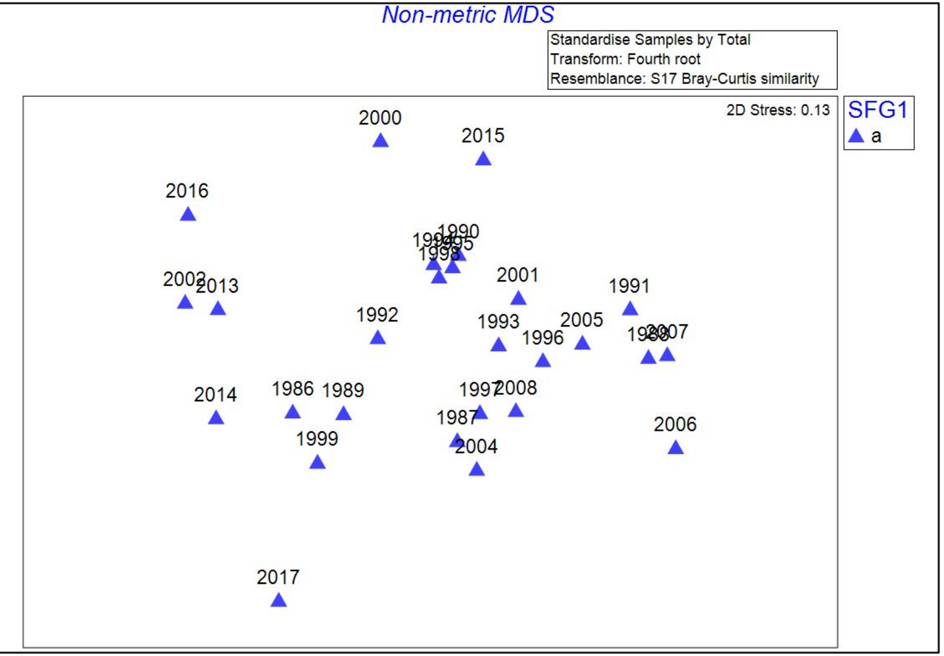


Without (larger) Gobies

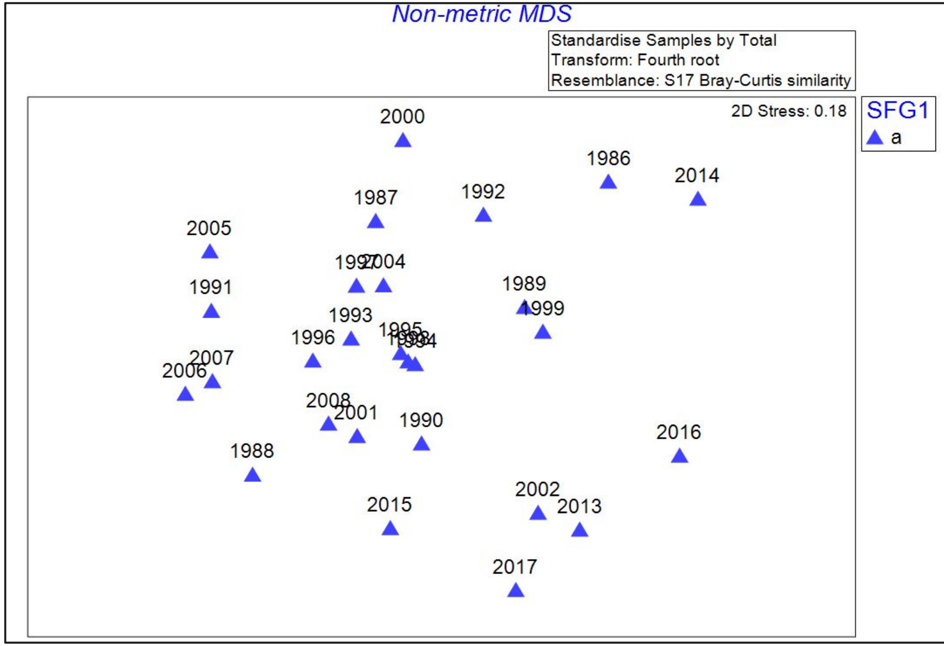


With (larger) Gobies

Comparing multivariate Fall data: East-West Channel

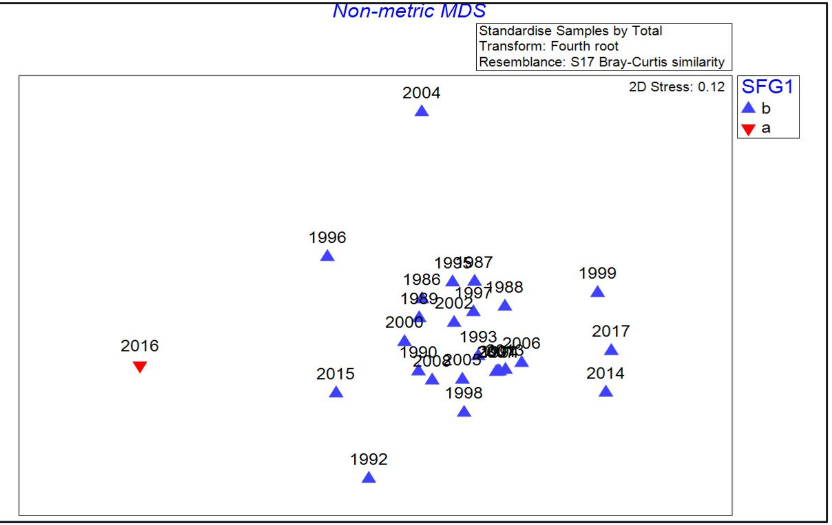


Without (larger) Gobies

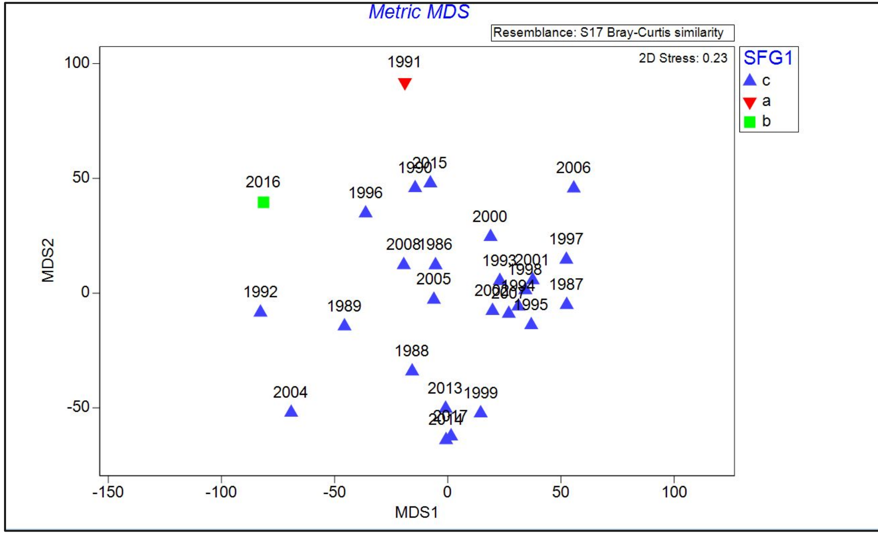


With (larger) Gobies

Comparing multivariate Fall data: Oneonta Slough



Without (larger) Gobies



With (larger) Gobies

b : Topsmelt ($2.43m^4$) and Killifish ($1.91m^4$)

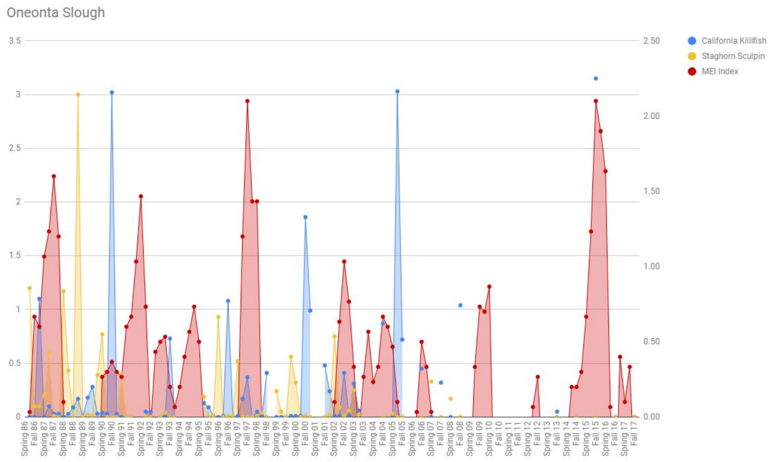
a : Longjaw Mudsucker ($2.45m^4$), Deepbody Anchovy ($2.46m^4$), and Longtail Goby ($2.29m^4$)

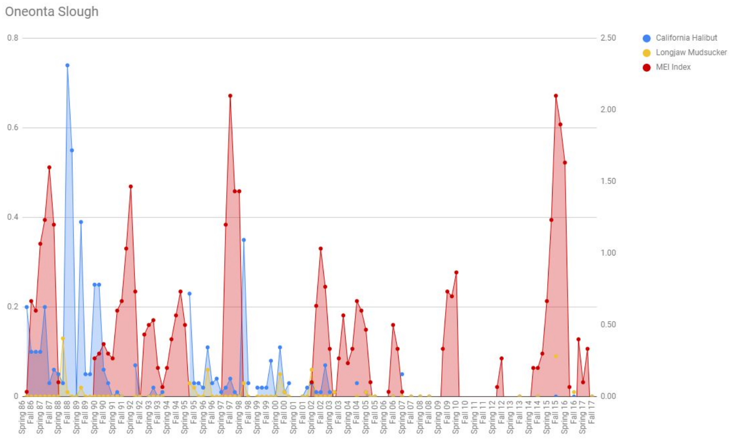
c : Topsmelt ($2.43m^4$) and Killifish ($1.91m^4$)

a : Longjaw Mudsucker ($2.45m^4$), Deepbody Anchovy $(2.46m)^4$, and Longtail Goby ($2.29m^4$)

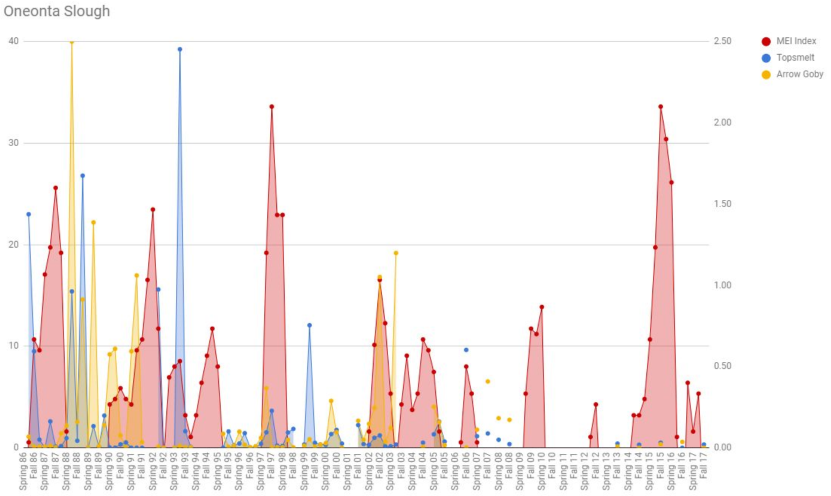
b: Topsmelt($2.30m^4$), Killifish ($1.80m^4$), Arrow Goby $(1.69m)^4$

Results of Historic Data: El Nino and Oneonta Slough

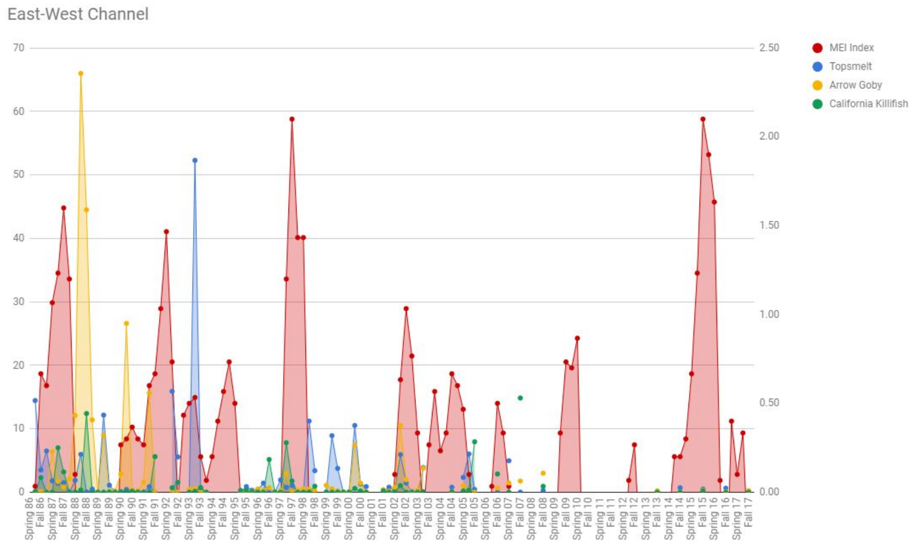


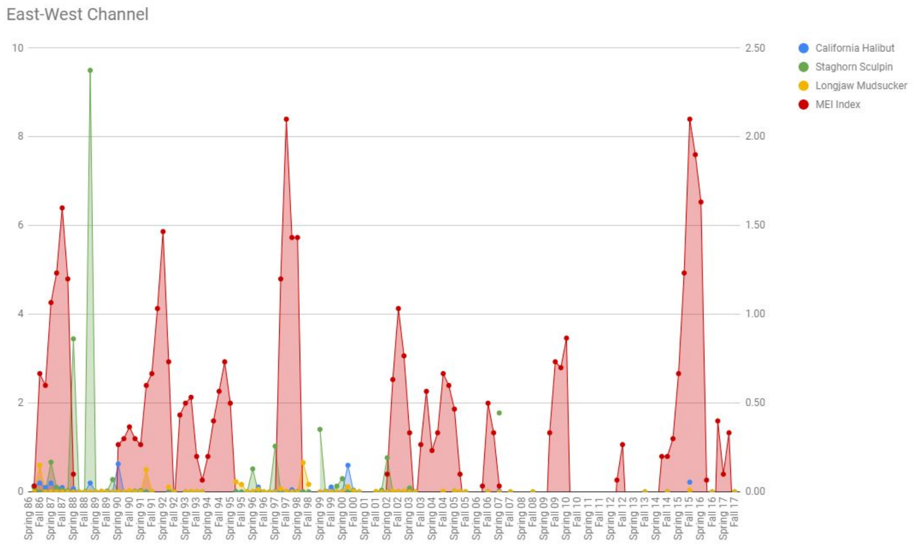


With no real trends between fish species, El Nino years seemed to have the most effect on fish populations



Results of Historic Data: East-West Channel

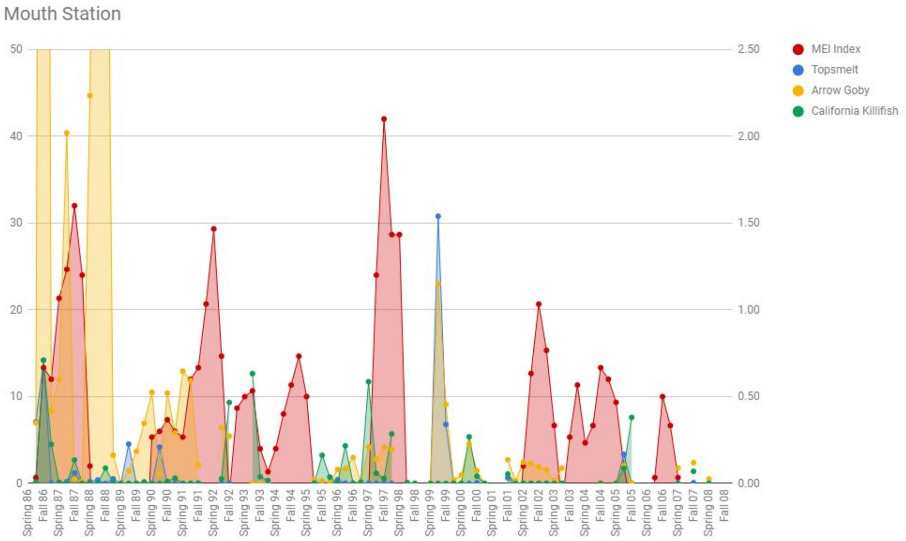


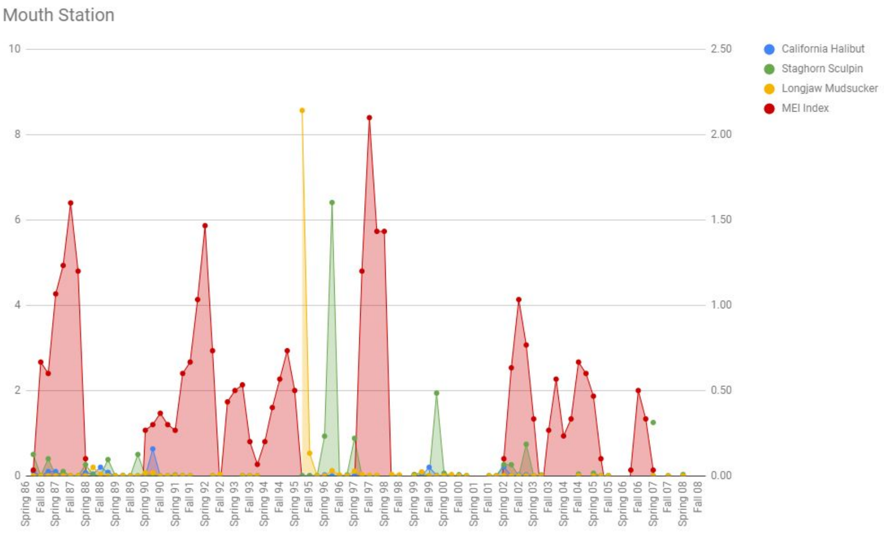


All graphs include all sampled seasons of Spring, Summer,

Fall, and Winter

Results of Historic Data: El Nino and Mouth Station

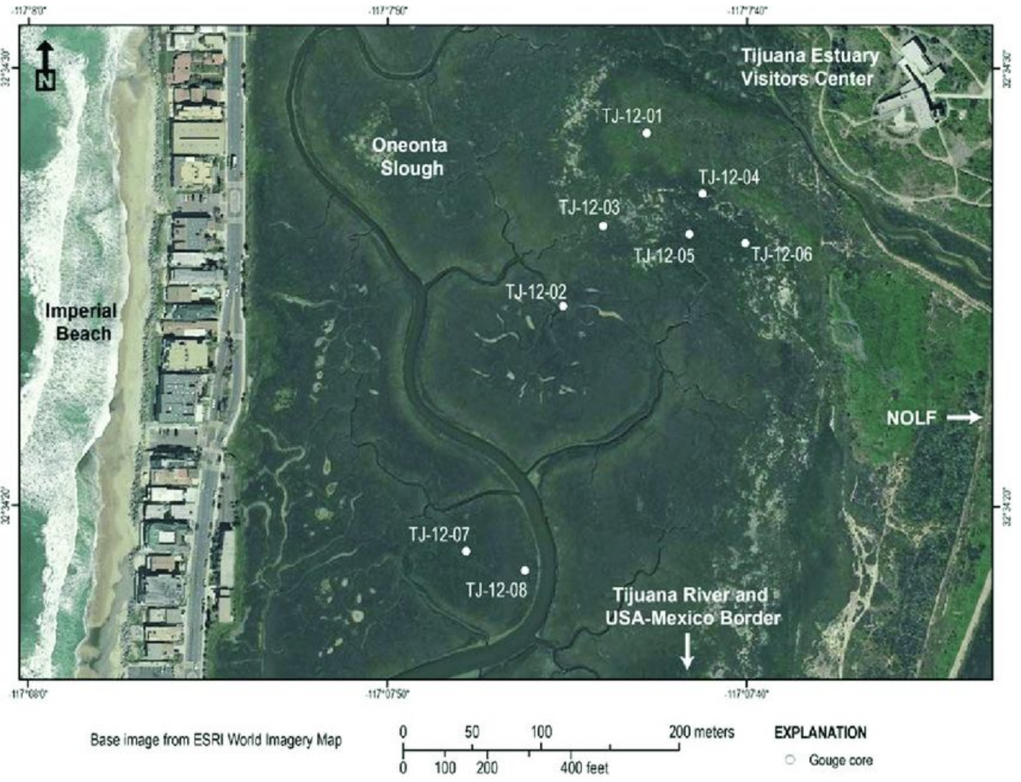




All non-El Nino years seem to have increased fish populations for

almost all species of fish

Results of Historic Data: Conclusions



- Based on qualitative fish data from the 1930's and small quantitative data from the 1970's, the fish community compositions have shifted
- Decline in less resilient fishes such as longjaw mudsuckers and California halibut most likely caused by sewage inflow
- Arrow Goby populations continued to survive as resilient fish with short lifespans and high fecundity
- From late 1980's to early 2000's dominance of Arrow Goby shifted to Topsmelt then back to Arrow Goby
- Increases and decreases of fish species populations remains highly variable
- El Nino conditions affect all species density

Future Factors to Consider: Peak Discharge

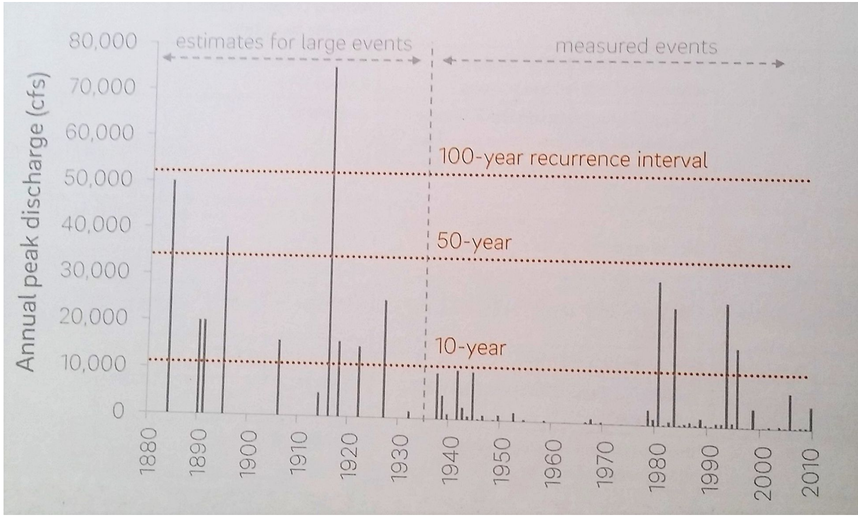


Figure 5.23 (left). Peak annual discharge (1880–2005), highlighting the years and magnitudes of major flood events. The estimated magnitude of floods with return intervals of 10 years (312 m^3/s [11,000 cfs]), 50 years (963 m^3/s [34,000 cfs]), and 100 years (312 m^3/s [52,000 cfs]) are provided for reference (URS Corporation 2012). Data prior to 1937 are estimates from the City of San Diego (1973) based on historical information and data from nearby streams. Data from after 1937 are derived from the gauge data shown and described on p. 99.

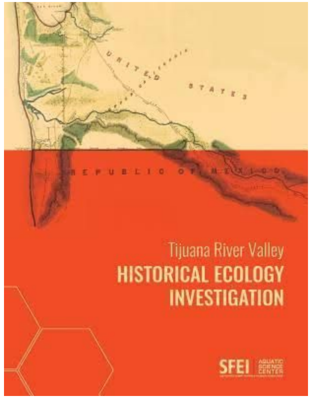


Table 6-1. Historical Extreme Events

DATE	Discharge (cfs)	Discharge (m^3/s)	RANK(5)
February, 1884	50,000(1)	1400(1)	2
December, 1889	20,000(1)	570(1)	8-9
February, 1991	20,000(1)	570(1)	8-9
January, 1895	38,000(1)	1100(1)	3
January, 1916	75,000(1)	2100(1)	1
February, 1927	25,000(1)	710(1)	6
February 7th, 1937	*17,700(2)*	*500(2)*	11
January 30th, 1980	31,000(1) **19,500(4)**	880(1) **547(4)**	10
February 21st, 1980	33,500(2, 3) **30,000(4)**	950(2, 3) **852(4)**	4
March 3rd, 1983	27,700(3) **24,500(4)**	780(3) **697(4)**	7
January 16th, 1993	33,000(3) **26,000(4)**	934(3) **731(4)**	5
February 20th, 1993	**17,500(4)**	**496(4)**	12
March 12th, 1995	**16,500(4)**	**464(4)**	13

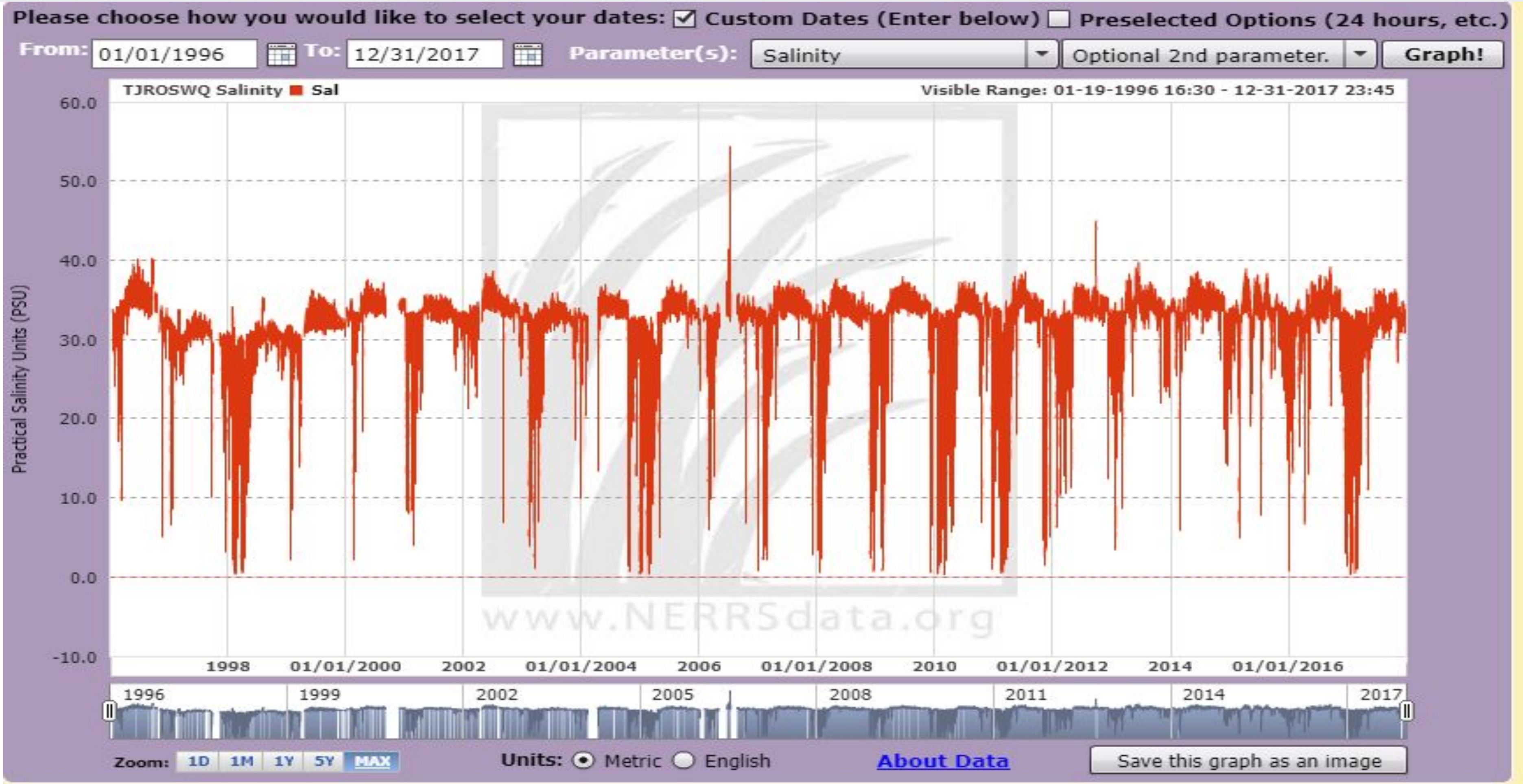
Notes:
(1): Estimations of past floods (made originally in cfs). Published on [2]. Values assumed to be peak flows.
(2): Peak flow measurements from the USGS Nestor Gauge (in cfs) according to [1a]
(3): Measurements according to References [2, 21]
(4): Measurements per published values of the IBWC [1]. Measurements published in m^3/s
(5): Rank and statistical properties obtained with bold values when two values exist.

As a consequence of Rodriguez and Barrett controlling 70.5 % of the watershed, extreme events prior to 1937 are not considered statistically comparable to those after that date. Also, although El Carrizo Dam affected hydrologic records since 1974, its contributing area is comparatively small. Consequently, it is assumed that El Carrizo does not change the hydrology of the peak discharges significantly, and therefore the peak flow records after El Carrizo started operation are statistically similar to those before that time.

As a conclusion, although the six events prior to 1937 (and four prior to 1900) are a good indication of the extreme peak flows that the Tijuana River watershed can generate, they will not be included in the statistical analysis as (1) the dams in the watershed have altered the hydrology and (2) those peaks are estimations and not measurements associated with a gauged station. Both aspects made those peaks unreliable for statistical purposes.

It must be pointed out that some extreme events are different when measured by IBWC [1] or when measured by the USGS Nestor Gauge as published by [2]. In order to be consistent in the statistical analysis, daily measurements by IBWC will be selected in those cases where two measurements exist.

Future Factors to Consider: Salinity



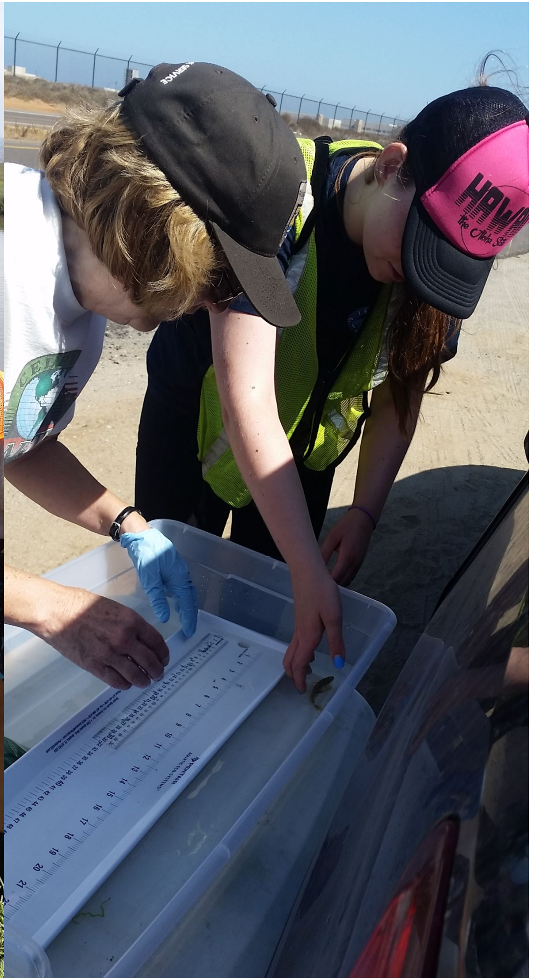
Mini Activities: State Parks Field Trip

Took photos for first field trip collaboration between the CA State Park and a local high school at Border FIeld with an emphasis on bridging science, history, and math.

Mini Activities: Monthly Data Logger Deployment

As part of the National Estuarine Research Reserve System Wide Monitoring Program to continuously take water quality measurements

Mini Activities: Preliminary Fish Health Analysis



Longjaw Mudsucker:
establish a health baseline

External Wholebody Assessments:

- length
- gender
- deformities
- external parasites
- gill status
- eye condition

Potential Future Collaboration: Fiddler or Blue Crabs

Tropicalization of Species: Fiddler Crabs and Blue Crabs

- How El Nino conditions are bringing tropical crab species
- Tropical crab species staying in San Diego
- Population density of fiddler crabs and blue crabs
- Fiddler crab burrows
- Effect of tropical crab species on native fish and crab species in the Tijuana Estuary


Questions?