

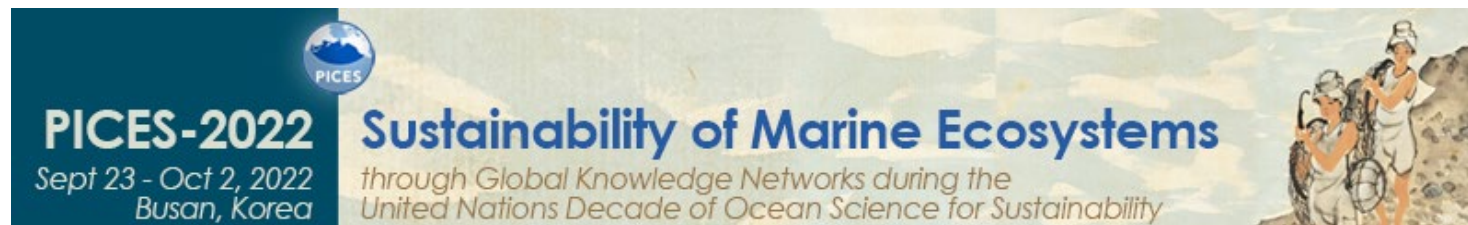


Assessing winter Gulf of Alaska biodiversity using eDNA surveys



PACIFIC SALMON
FOUNDATION

Svetlana Esenkulova and Christoph Deeg



Winter High Seas Expedition

International Year of the Salmon's 5-year initiative, with 3 High Seas Expeditions to study the winter ecology of salmon and discover the mechanisms regulating salmon in the North Pacific Ocean.

Goals:

- Determine species and stock-specific ocean distributions, relative abundances, condition of salmon, and factors or mechanisms controlling their growth and survival
- Document the spatial and temporal variation in physical and biological oceanographic conditions, zooplankton and nekton
- Demonstrate the ability to effectively collaborate across the five North Pacific Anadromous Fish Commission (NPAFC) parties and our partners to conduct integrated ecosystem research that will support the sustainable management of salmon in a rapidly changing North Pacific Ocean.

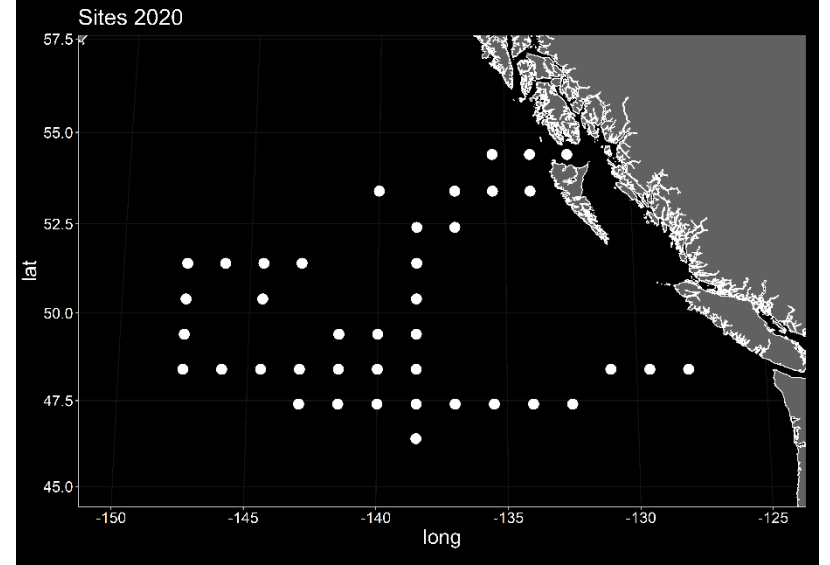
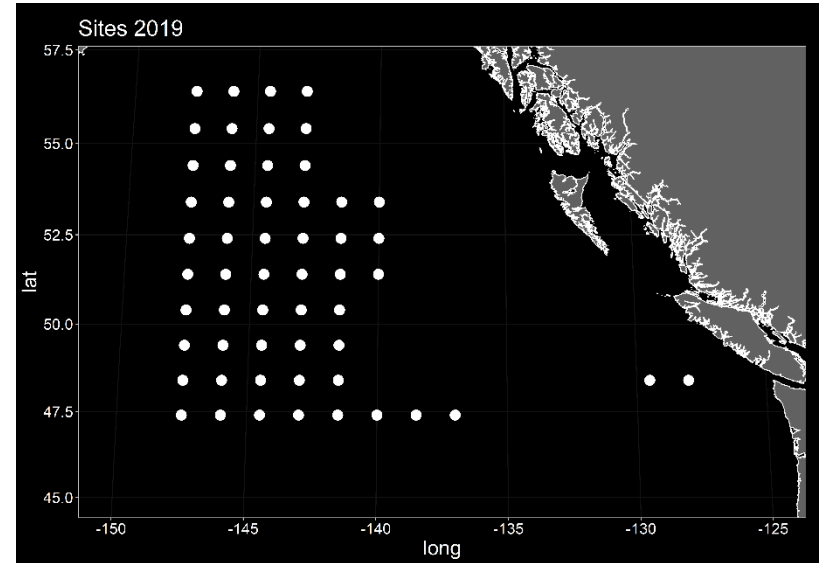


Richard Beamish, Brian Riddell, Mark Saunders





IYS Gulf of Alaska (GoA) Expeditions 2019 & 2020



2019 Gulf of Alaska winter expedition – RV Pr. Kaganovsky



- The first comprehensive expedition looking into winter salmon ecology in GoA



- International crew - 5 countries NPAFC
- 5 weeks at sea
- Temperature anomaly - the blob



- Summary of preliminary findings - Pakhomov et al., 2019. NPAFC Doc. 1858

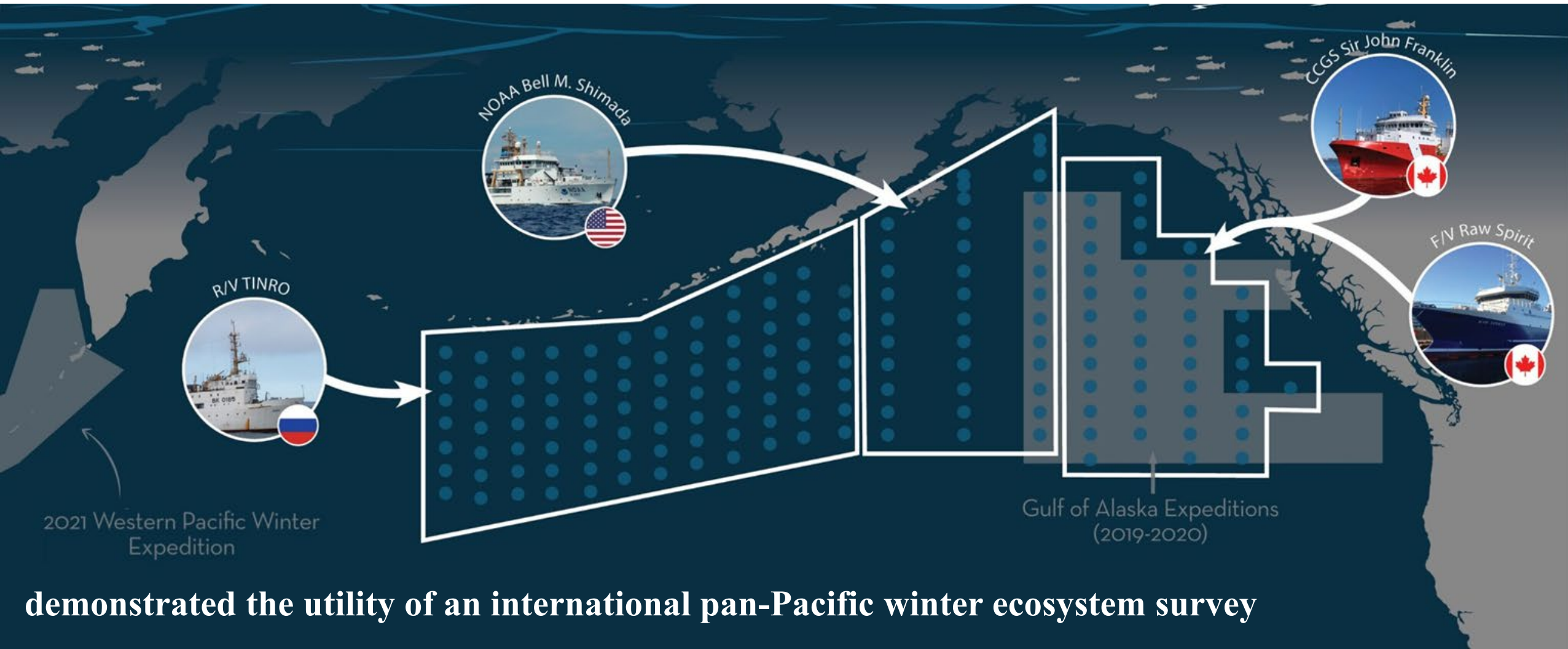
Slide from Dr. Weitkamp presentation for PICES 2020 and NOAA

2020 Gulf of Alaska winter expedition – FV Pacific Legacy

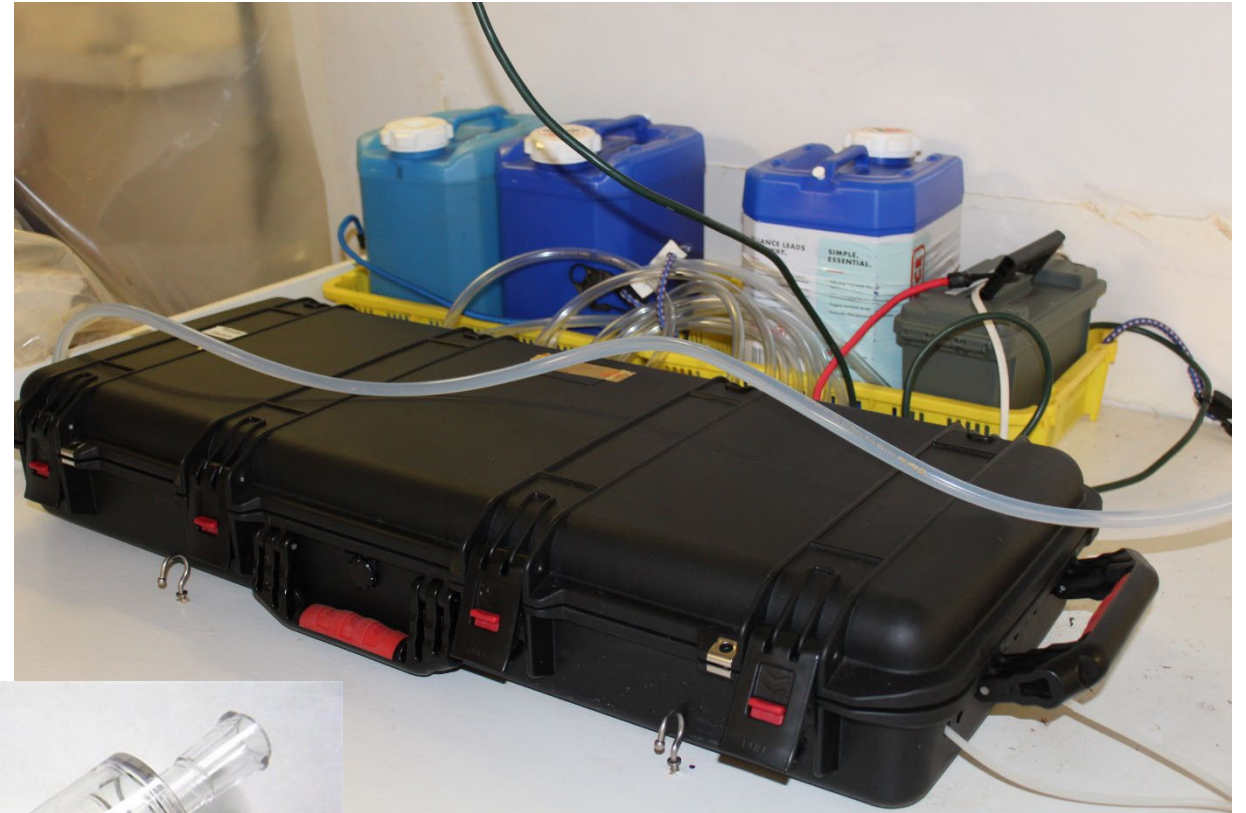
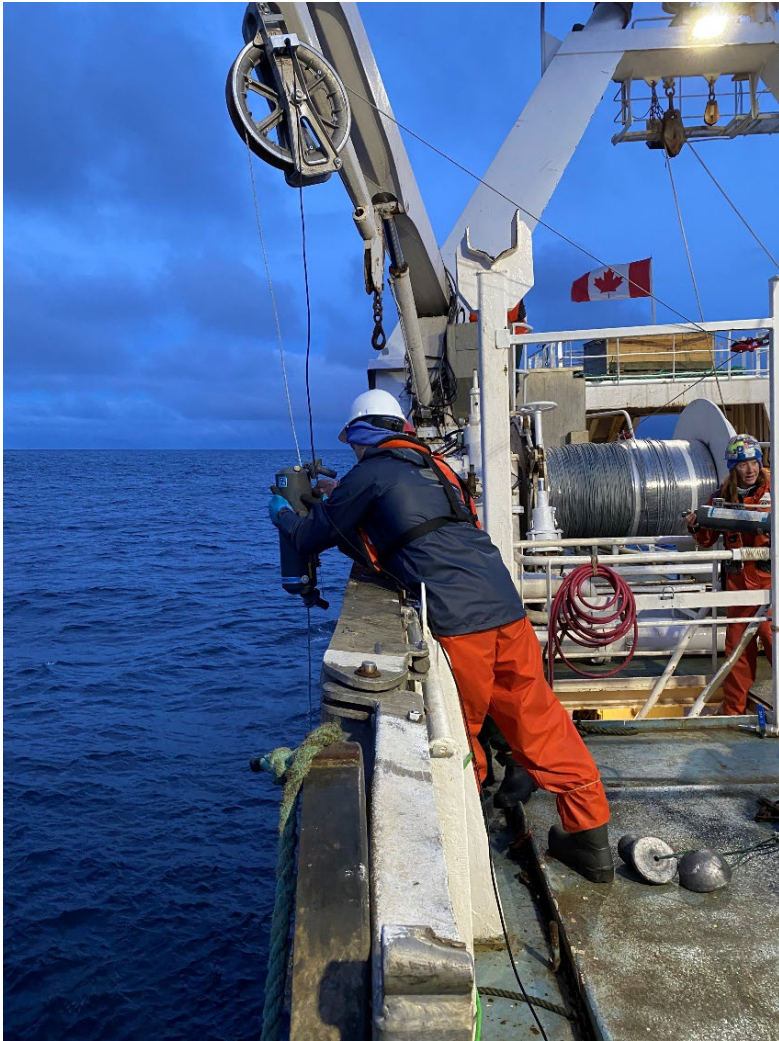


- International crew - 3 countries
- 4 weeks at sea
- COVID happen
- Russian scientists stuck in Canada for 2 months
- Summary of preliminary findings - Somov et al., 2020. NPAFC Doc. 1930

2022 Pan-Pacific expedition – the LARGEST, multinational study of winter salmon ecology

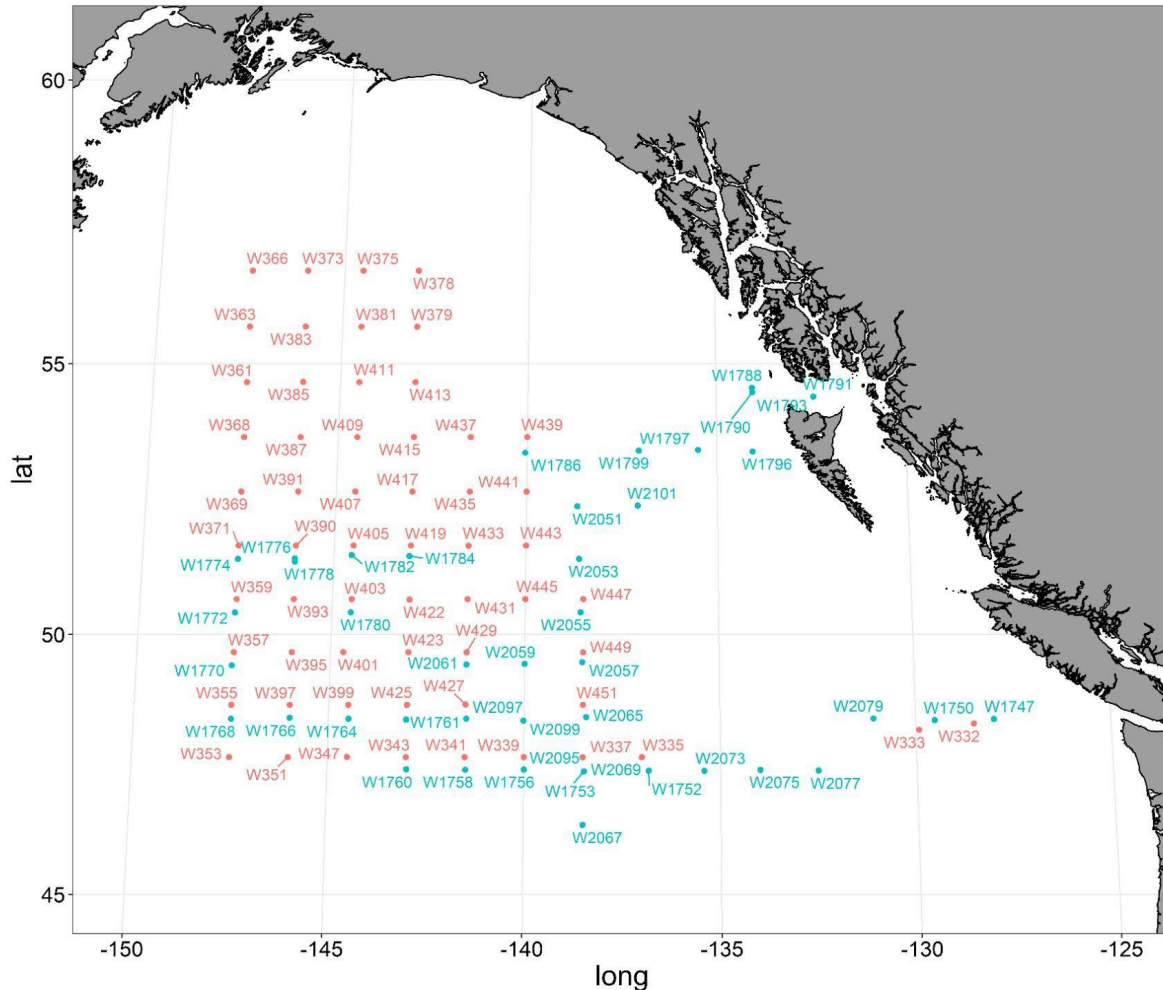


eDNA samples



2L x2 from 2-4 m
filtered into 0.22 μm Sterivex
preserved in RNALater
2019 (n=62) and 2020 (n=46)

Samples and data processing



DNA extracted with the DNeasy (QIAGEN), yield assessed with Qubit fluorometer
rDNA amplicons - 16S and COI
Data processed with FastQC, OBITools suite, BLAST, MEGAN

Based on field and lab controls - amplicon specific baseline contamination level was established as 20

OTU

full analysis pipeline is on GitHub

https://github.com/ViralChris/eDNA_metabarcoding

The entire dataset is at

https://iys.hakai.org/dataset/ca-cioos_223a40da-5999-4755-a8f4-cbaee3057278

2019

2020

2019

2020

eDNA

trawl

eDNA

trawl

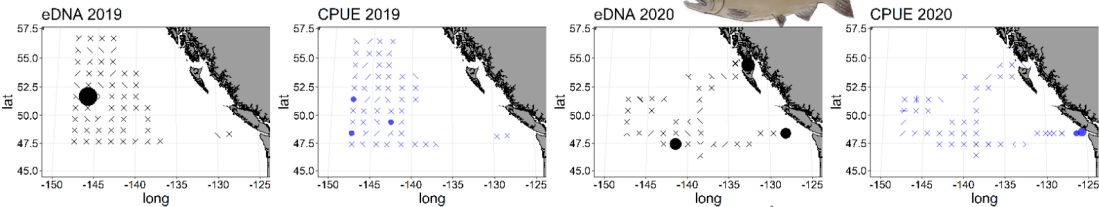
eDNA

trawl

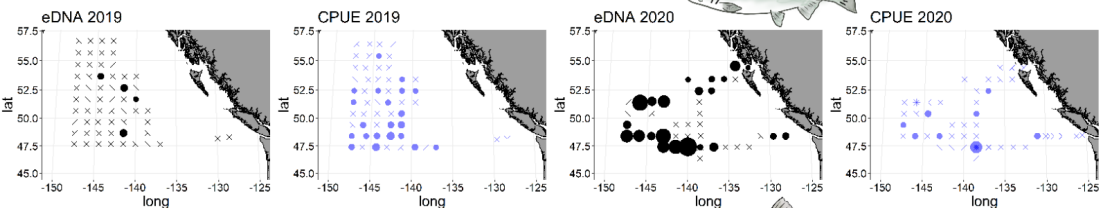
eDNA

trawl

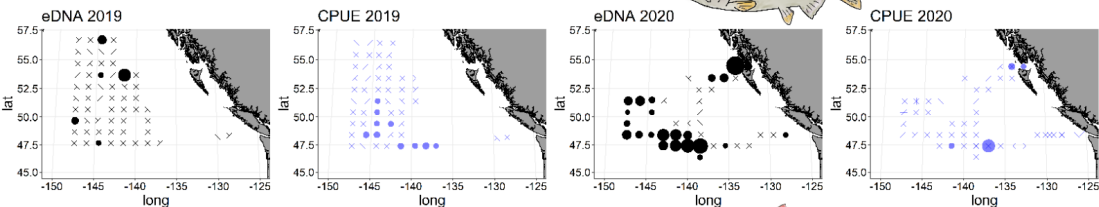
Oncorhynchus tshawytscha



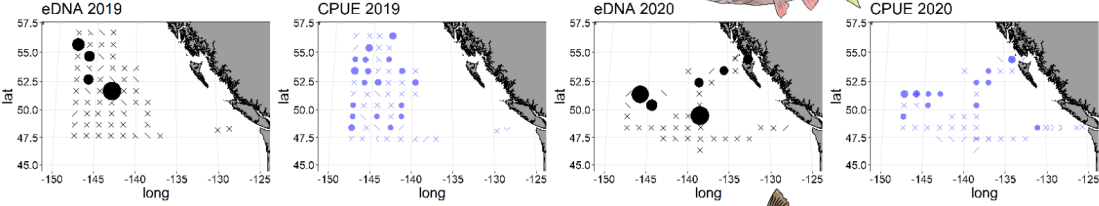
Oncorhynchus kisutch



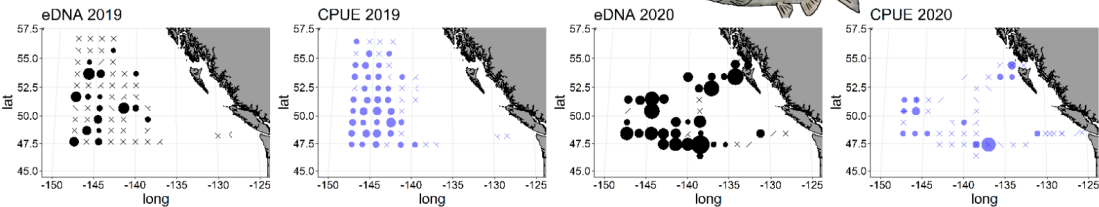
Oncorhynchus gorbusha



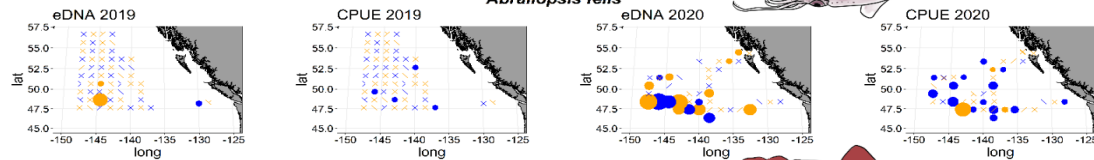
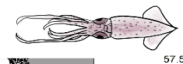
Oncorhynchus nerka



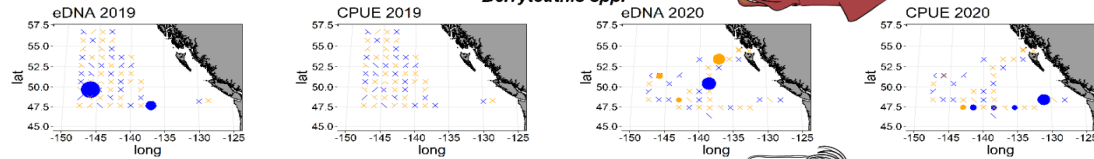
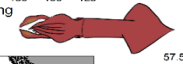
Oncorhynchus keta



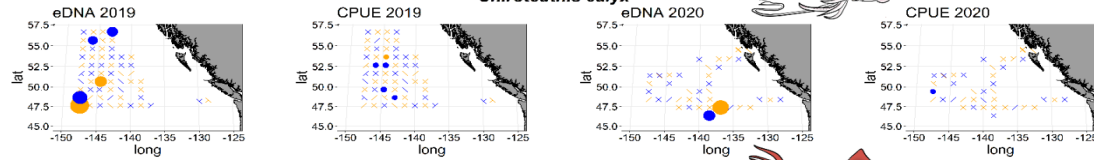
Abraliopsis felis



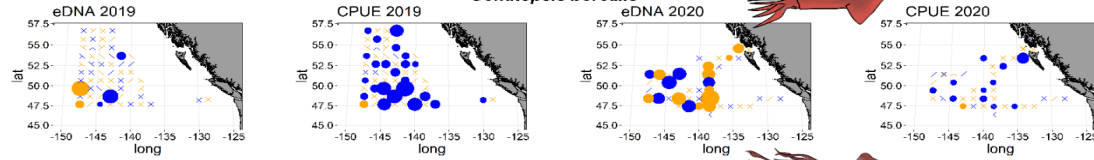
Berryteuthis spp.



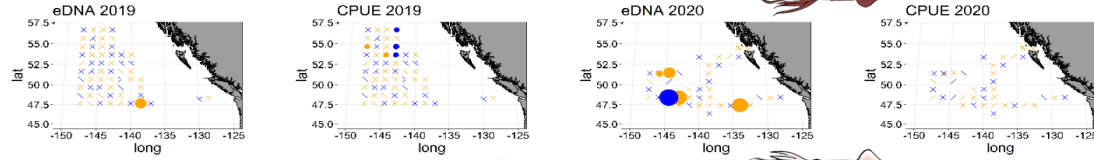
Chiroteuthis calyx



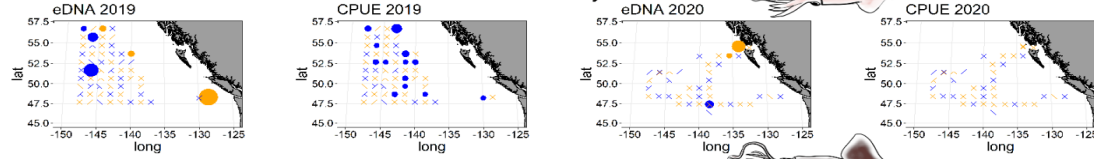
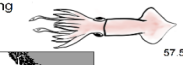
Gonatopsis borealis



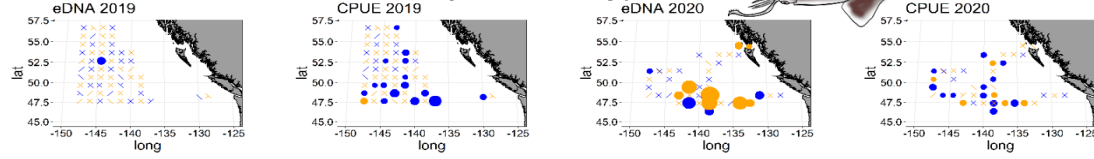
Gonatus madokai



Gonatus onyx



Onychoteuthis borealijaponica



Species detection

Taxon levels and number of reads detected by COI and 16S

Kingdom	Category	Taxon level	2019		2020	
			Count	Reads	Count	Reads
Animalia	Fish	Species	21	1699774	31	11966278
	Fish	Genus	10	143771	16	990094
	Fishes	Higher rank	4	23968	10	345430
	Copepod	Species	12	10568738	16	9128348
	Copepod	Genus	3	652795	3	534291
	Copepod	Higher rank	4	375337	3	203469
	Squid	Species	8	50716	8	101758
	Squid	Genus	4	18411	5	124543
	Squid	Higher rank	1	2871	1	3847
	Jellyfish	Species	3	1889772	3	2798
	Jellyfish	Genus	4	11124	2	446
	Jellyfish	Higher rank	5	880	1	57
	Other	Species	17	5404321	24	8748836
	Other	Genus	5	36270	12	10071
	Other	Higher rank	97	12604	131	572263
Plantae	Other	Species	2	195	1	30
	Other	Genus	4	556	2	144
	Other	Higher rank	7	19639	7	7272
Fungi	Other	Species	2	3415	3	1669
	Other	Genus	0	0	0	0
	Other	Higher rank	2	340	1	151
Protista	Other	Species	88	3002162	81	745432
	Other	Genus	45	587220	34	347655
	Other	Higher rank	43	1047839	40	239698
Prokaryota	Other	Species	13	180757	8	14198
	Other	Genus	7	68278	5	10591
	Other	Higher rank	6	1203338	6	125968

Taxon levels and number of specimens in trawls

Category	Taxon level	2019		2020	
		Count	Specimens	Count	Specimens
Fish	Species	19	6479	22	17284
Fish	Genus	1	10	2	7419
Squid	Species	9	2258	8	1576
Squid	Genus	2	2	1	31
Jellyfish	Species	6	6572	5	1069
Jellyfish	Genus	2	56	5	22

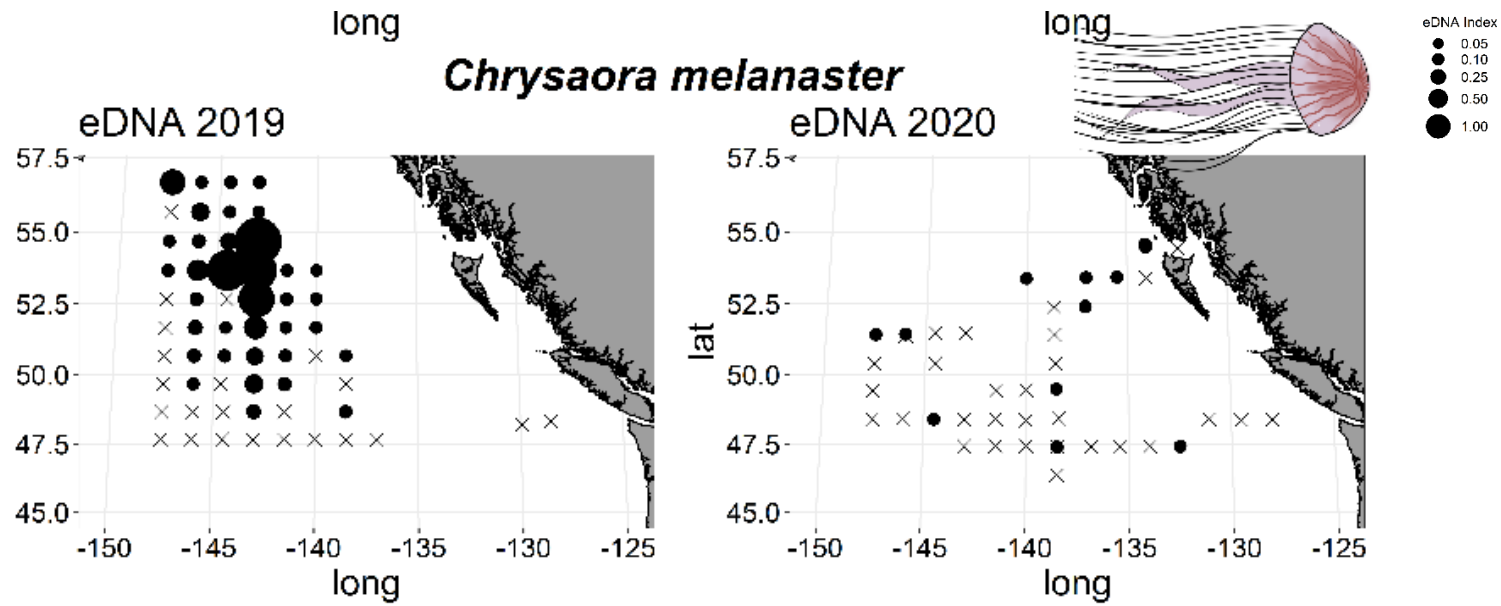
Correlations between eDNA and trawl:

Species Richness (SR) eDNA/trawl for fish+squid+jellies – very low

Individual species OTU/ significant positive correlation for Chum, Bigfin lanternfish, and Boreopacific armhook

Copepods (*Mesocalanus tenuicornis*, *Neocalanus plumchrus*, *Paraeuchaeta* spp.) significant positive (r=0.33-0.48) Juday net small+medium zooplankton counts

Northern sea nettle *Chrysaora melanaster*



2019

exceptionally abundant in trawl catches in the northern part of the GoA

eDNA detections confirmed this observation + placing the distribution center further to the east

2020

Widely distributed, low relative abundances

negative predictive interaction with Chum salmon

Northern sea nettle *Chrysaora melanaster*



Common species on continental shelves, prior to 2019 had not been observed in the GoA

During our survey in 2019, this jellyfish surpassed salmon (dry) biomass by a factor of five (Pakhomov et al., 2019)

C. melanaster prey on large crustacean zooplankton and small fish (Decker et al., 2014)

During GoA 2019 expedition *C. melanaster* was negatively associated with four copepod species

direct ecosystem effect or an indicator species? unusual ocean conditions associated with marine heat wave? unusual recruitment of species from the northern continental shelf?



Summary



- First eDNA baseline for winter epipelagic Gulf of Alaska communities
- Good detection, especially for vertical diurnal migrators, higher species richness, avoiding catch bias
- Good correlation (OTUs/catch) for small organisms (*i.e.* copepods)
- eDNA open ocean - low species diversity, eddies and shelf – high
- Northern sea nettle (*Chrysaora melanaster*) during marine heatwave in 2019 – negative association with Chum salmon
- eDNA for ecosystem research – complement and improve results obtained with traditional survey methods