EXPORTS

EXport Processes in the Ocean from RemoTe Sensing

Implementation Plan

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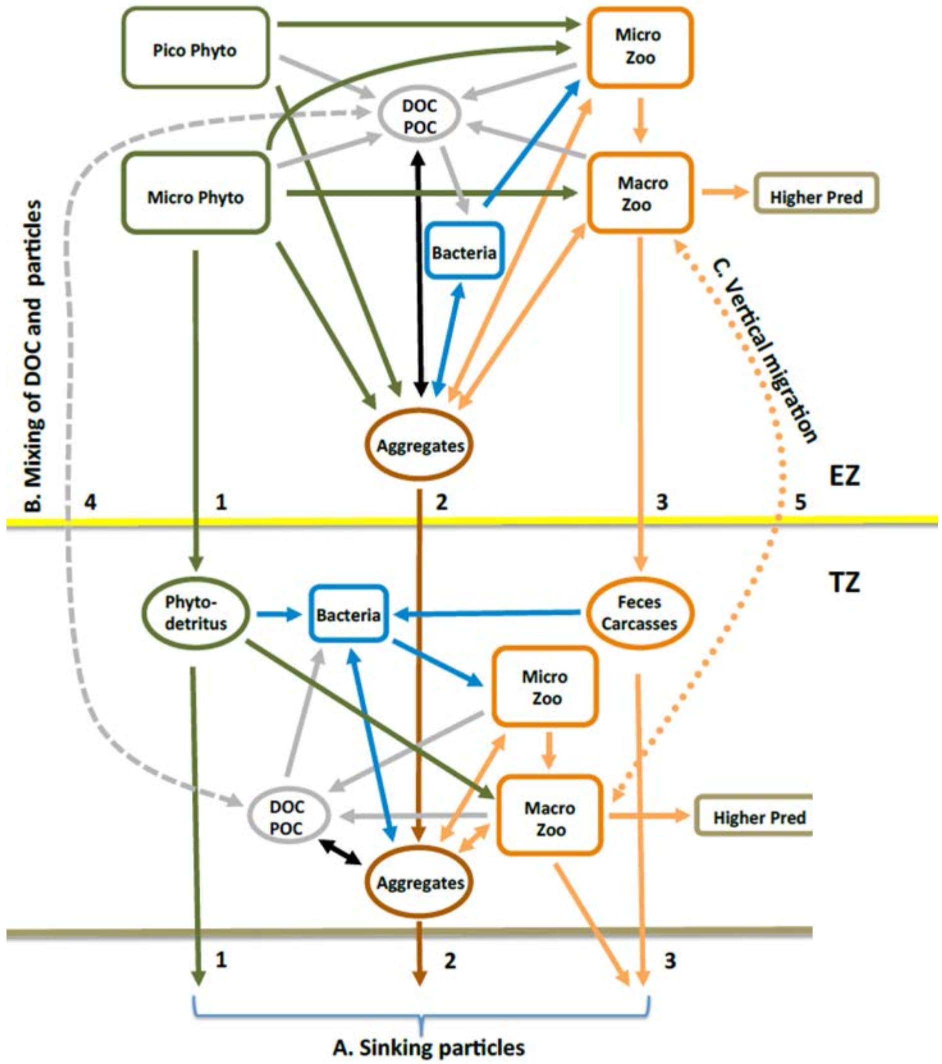
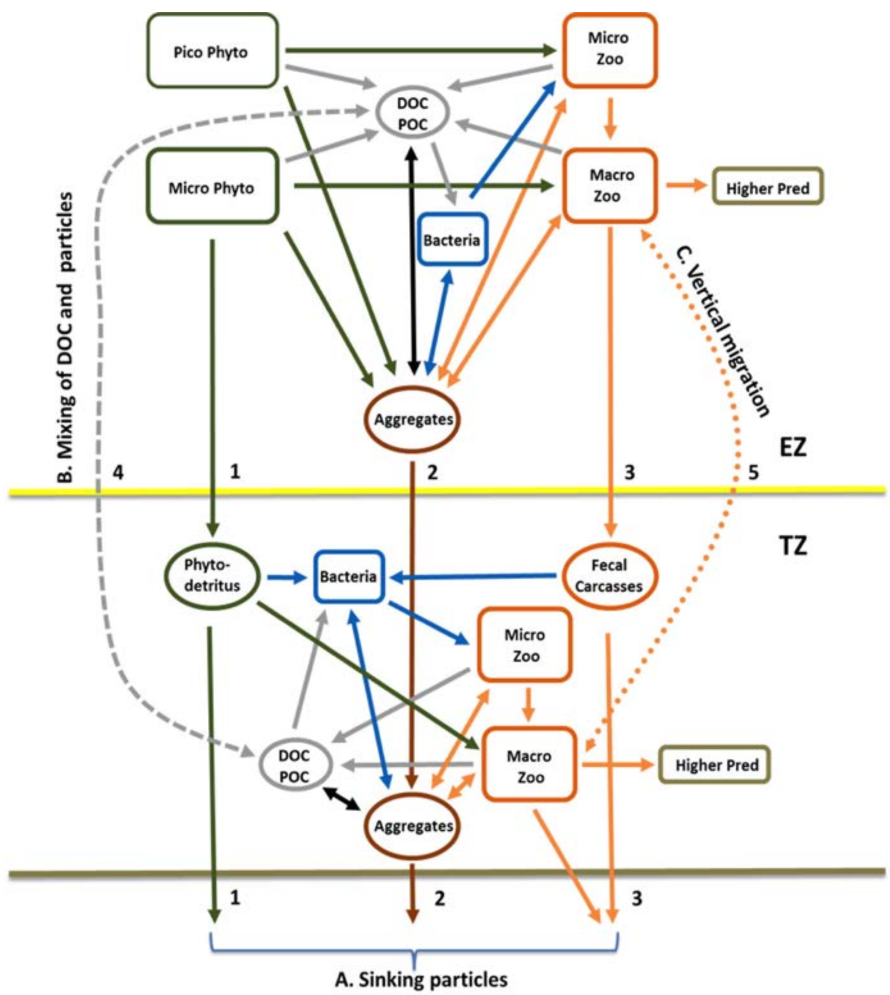
EXport Processes in the Ocean from RemoTe Sensing (EXPORTS)

5 Export Pathways

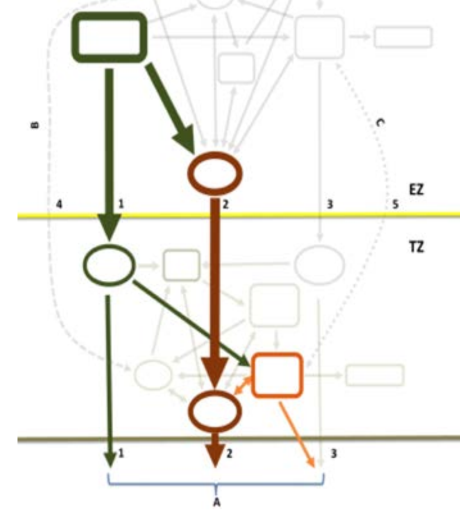


3 Science Questions

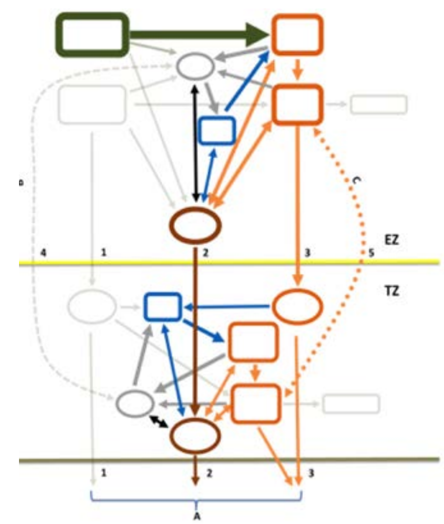
Ecosystem and Carbon Cycling (ECC) state



North Atlantic Bloom



Northeast Pacific Summer



Talk outline

- **How did we come up with the goal plan?**
- Highlights of the goal plan
- Cost estimate for the goal plan
- Alternatives to the goal plan, to fit different budget scenarios

EXPORTS Science Definition Team

- GOAL PLAN = SDT's **best suggestion** for implementation that **answers the science questions** with a **high degree of certainty**

- Alternatives to the goal plan, to fit different budget scenarios

➢ GOAL PLAN = SDT's best **suggestion**

- How might the Goal Plan be improved, to better answer the science questions?
- In choosing between implementation options, which risks are easiest to accept, and which science is the most valuable?
- Could the suggested management structure be more effective?
- Should the proposed timeline or geographic sampling strategy be altered?

We want your questions and comments!

- Right after this talk, during group discussion
- Watching the webstream? Live email: ocb_live@whoi.edu
- Early career? At lunch today, look for EXPORTS tables
- Email to: obb_comments@cce.nasa.gov, by Sept. 1

- Start with the Science Questions
- Create detailed list of measurements necessary to robustly answer each question
- Prioritize the measurements
- Account for any logistical constraints to carrying out the measurements

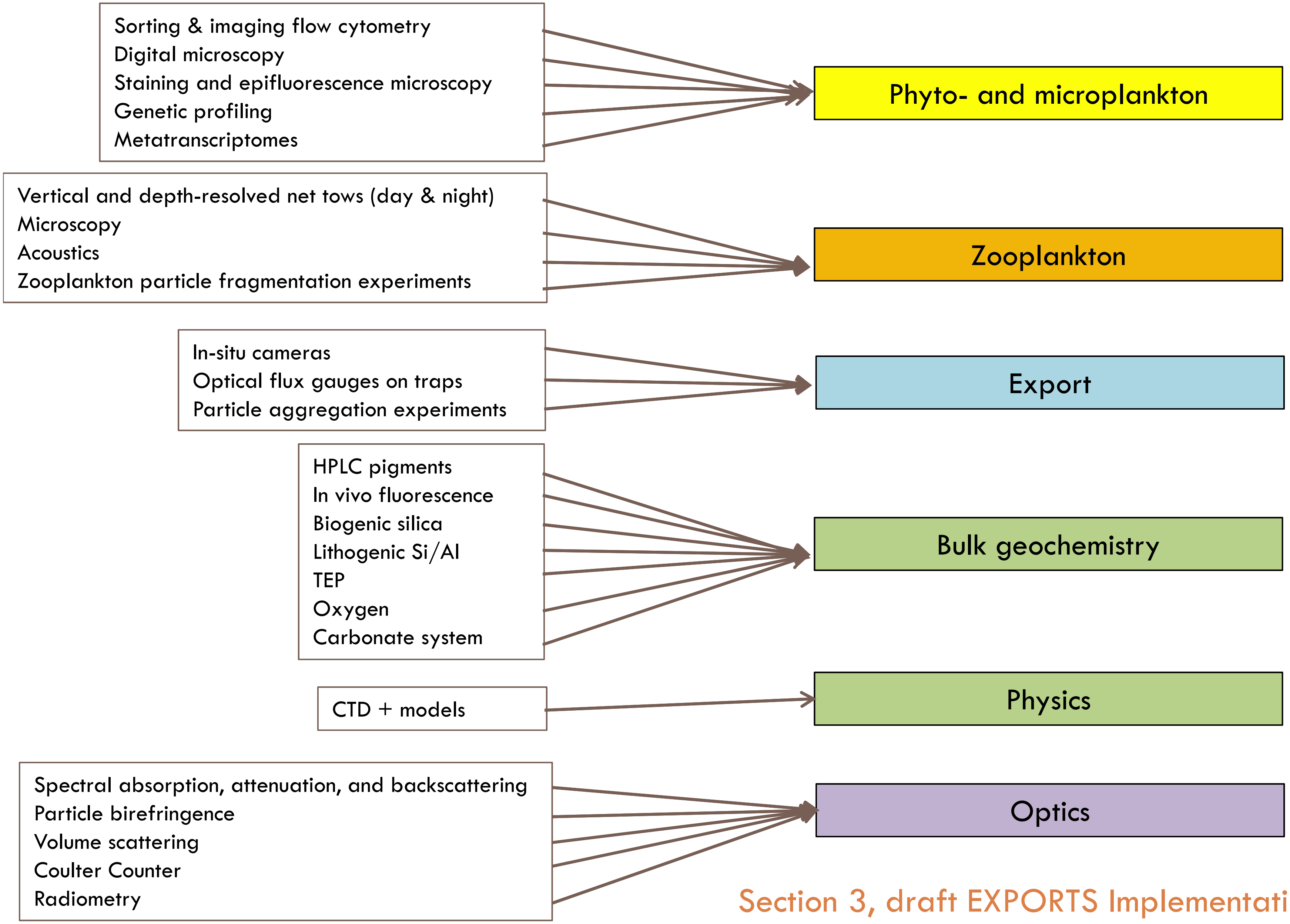
Table 1 from draft Implementation Plan: EXPORTS Science Questions and sub-questions

SQ1	**How do upper ocean ecosystem characteristics determine the vertical transfer of organic matter from the well-lit surface ocean?**
1a	*How does plankton community structure regulate the export of organic matter from the surface ocean?*
1b	*How do the five pathways that drive export (cf., sinking of intact phytoplankton, aggregates or zooplankton byproducts, vertical sub-mesoscale advection & active vertical migration) vary with plankton community structure?*
1c	*What controls particle aggregation / disaggregation of exported organic matter and how are these controls influenced by plankton community composition?*
1d	*How do physical and ecological processes act together to export organic matter from the surface ocean?*
SQ2	**What controls the efficiency of vertical transfer of organic matter below the well-lit surface ocean?**
2a	*How does transfer efficiency of organic matter through the mesopelagic vary among the five*
	production?
3b	*How do key planktonic ecosystem characteristics vary and can they be assessed knowing surface ocean processes alone?*
3c	*Can the export and fate of upper ocean net primary production be accurately modeled from satellite-retrievable properties alone or will coincident in situ measurements be required?*
3d	*How can the mechanistic understanding of contemporary planktonic food web processes developed here be used to improve predictions of the export and fate of upper ocean net primary production under future climate scenarios?*

EXAMPLE: SQ1c. What controls particle aggregation/disaggregation of exported organic matter and how are these controls influenced by plankton community composition?

Section 3, draft EXPORTS Implementation Plan

SQ1c. What controls particle aggregation/disaggregation of exported organic matter and how are these controls influenced by plankton community composition?



Section 3, draft EXPORTS Implementation Plan.

Talk outline

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EXPORTS complete measurement table

Complete Measurement Table - List of possible EXPORTS measurements along with science questions they address with notes on priorities, platforms, survey vs process ship preferences

See separate footnote document with more extensive notes corresponding to item number.

Date: July 6, 2016

Priorities for Survey & Process ships & related Science Question (1= essential to address science question; 2 = useful). Survey UW: a= surf water, b = towed. Autonomous platforms: a= long term Lagrangian, b= long term distributed, c= process cruise.

Item #	Program element-type	Platform	Methods-shorthand	EXPORTS science question needs	Measurement types & examples	Purpose	Questions Addressed Q1	Questions Addressed Q2	Q1 Survey UW Q1	Q1 Survey vertical Q1	Q2 Survey vertical Q2abcd	Q1 Process vertical Q1	Q2 Process vertical Q2abcd	Q1 AUV/ASV deploy & retrieve Q1	AUVs Q1/Q2	Data prod 1e
1	Phyto/micro plankton	CTD	FCM	Phytoplankton biomass proxies and diversity	flow cytometry (number, volume, groups); imaging cyt	Routine measurements relatable to phytoplankton biomass (chlorophyll requires C	1abc		2- a	1	no	1	2	2	no	4
2	Phyto/micro plankton	CTD	FCM	Phytoplankton biomass	sorting flow cytometry/imaging	Analytical measurement of phytoplankton carbon biomass	1abc		no	no	no	1	2	2	no	4
3	Phyto/micro plankton	CTD	FCM	Heterotrophic prokaryote concentration (cell number) and size/volume, including	e.g., flow cytometry with staining and epfluorescencei	Bacterial numbers, bacterial carbon, also viruses.	1abcd	2abcd	2- a	1	1,2	1	1, 1	2	no	4
4	Phyto/micro plankton	CTD	FCM	Heterotrophic nanoflagellate and larger protist concentration (cell number) and s	e.g., flow cytometry, digital imaging microscopy, invert	Size spectrum of heterotrophic protist community and C content.	1abc	2abcd	2- a	1	2, 2	1	2, 1	2	no	3
5	Phyto/micro plankton	CTD	sensor	Variable Fluorescence	variable fluorescence Fv/Fm	ph										2
6	Phyto/micro plankton	CTD	omics	Phytoplankton community composition	DNA-based community composition (genetic profiling	Qu										3
7	Phyto/micro plankton	CTD	omics	Heterotrophic prokaryotic community composition	DNA-based community composition (genetic profiling	Qu										3
8	Phyto/micro plankton	CTD	omics	Heterotrophic protist community composition	DNA-based community composition (genetic profiling	Qu										4
9	Phyto/micro plankton	CTD	experimental - omics	Phytoplankton metabolism	nutrient manipulations with gene expression	as										2
10	Phyto/micro plankton	CTD	geochem	Net Community Production	NCP (O2/Ar)	ne										2
11	Phyto/micro plankton	CTD	experimental	Phytoplankton Productivity	NPP/NCC (14C)	net primary production (NPP) and net cocco calcification (NCC)	1ab		no	no	no	1	no	no	no	2
12	Phyto/micro plankton	CTD	geochem	Phytoplankton Productivity	GPP (triple O isotope)	gross primary production averaged space and time	1ab		2- a	no	no	1	no	no	no	2
13	Phyto/micro plankton	CTD	experimental	Phytoplankton Productivity	GPP (18O)	gross primary production by incubation, either deck or in situ	1ab		no	no	no	2	no	no	no	2
14	Phyto/micro plankton	CTD	experimental	Viral infection & dilutions	various includingFCM, electron microscopy & probes, r	Estimation of viral infection and rates of mortalitiy due to viruses	1ab		no	no	no	1	no	no	no	7
15	Phyto/micro plankton	CTD	experimental	Heterotrophic Bacterial Production	3H Tdr or 3H Leu incorpration method	Estimation of heterotrophic bacterioplankton production	1d	2abcd	no	no	no	1	1, 1	1	no	8
16	Phyto/micro - remin	CTD	experimental	DOM remineralization Exp	Seawater Dilution cultures	Estimation of DOM bioavailabilty and persistence & for bacterial C demand	1d	2abcd	no	no	no	1	1, 1	1	no	6
17	Zoo	nets	community	Zooplankton metazoan concentration (cell number) and size/volume	Net Tows - vertical	Zooplankton abundance and C biomass totals	1abc	2abcd	no	1	1, 2	1	1, 1	1	no	3
18	Zoo	sensor	accoustics	Zooplankton metazoan biomass	Acoustics	Zooplankton biomass patchiness and diel migration	1abc	2abcd	1- UW	no	1, 1	2	2,2	2	2a, 2c	1
19	Zoo	nets	day/night tows	Zooplankton metazoan concentration (cell number) and size/volume	Net tows- day/night depth resolved with microscopic c	Siz										1
20	Zoo - remin	nets	experimental	Fragmentation	Experiments with zooplankton impacts on particle size	stu										5
21	Zoo - remin	nets	experimental	Zooplankton metabolism (respiration and excretion)	Net tows to collect; SPOT method, weight-specifc met	me										8
22	Zoo - remin	nets	experimental	Microzooplankton Grazing	Ship based dilution experiments	mi										8
23	Zoo - remin	nets	experimental	Mesozooplankton Grazing	multi prong approaches - see comments	me										8
24	Zoo - remin	nets	experimental	Mesozooplankton fecal pellet production	fecal pellet ID and production experiments	rep										8
25	Fish	sensor	accoustics	Fish (tertiary consumers/carnivores) biomass	Acoustics- hull mounted	fish patchiness, diel vertical migration		2d	1- UW	no	no	no	no	no	no	3
26	Export	trap	deploy-CHN/mass	Particle flux EZ & TZ- trap based	Sediment traps for direct collection of major flux com	Flux vs. depth of mass, POC, PIC, bSi, N, P, Lithogenics, TEP	1ab	2abcd	no	no	no	1	1, 1	no	1c	1
27	Export	trap	geochem	Particle flux EZ & TZ- trap based	Sediment traps for biomarkers	to link what is sinking to EZ source material	1ab	2abc	no	no	no	1	2	no	no	1
28	Export	trap	omics	Particle flux EZ & TZ- trap based	Sediment traps for omics	to link what is sinking to EZ source material	1ab	2abc	no	no	no	1	2	no	no	1
29	Export	trap	gels	Particle flux EZ & TZ- trap based	Sediment traps for ID - polyacrilimide gel traps	to link what is sinking to EZ source material	1ab	2abcd	no	no	no	1	1, 1	no	no	1
30	Export	CTD	geochem	Particle flux EZ & TZ- in situ tracers	234Th flux studies (also need large particle X/Th ratio)	quantify spatial and vertical sinking flux POC, PIC, bSi, PON, POP	1ab	2abcd	2- a	1	1,2	2	2,2	2	no	1
31	Export	CTD	geochem	Particle flux EZ & TZ- in situ tracers	210Po, 228Th flux studies	quantify sinking flux as with 234Th but on longer time scales	1ab	2abc	no	2	no	no	no	2	no	1
32	Export- particles	in situ pump	geochem	size fractionated particle collection	large particle collection - in situ pumps (w/234Th)	me										4
33	Export	trap	optics	Particle flux EZ & TZ- trap based	Optical flux gauges (on trap and/or independent float)	Flu										1
34	Export- PSD	trap	cameras	Particle flux EZ & TZ- proxies	In situ cameras on traps	pa										1
35	Export- PSD	Multi	cameras	Aggregate PSD and flux derived from particle distributions	particle cameras (e.g., UVP, VPR, LOPC, etc.)	Ch										1
36	Export- PSD	Multi	cameras	Zooplankton metazoan biomass	In situ camera (e.g., UVP, VPR)	Zo										1
37	Export- remin	trap	experimental	Sinking velocity	Settling Velocity Traps or other in situ devices	sin										1
38	Export - remin	CTD	experimental	Sinking velocity	Settling columns	sinking rates- usually done shipboard	1ab	2d	no	no	no	2	1	no	no	1
39	Export - remin	trap	experimental	In Situ Microbial metabolism, whole water	in situ or pressurized incubation chamber water	heterotrophic metabolism of OM & chemoautotrophy	1abd	2abcd	no	no	no	1	1, 1	no	no	8
40	Export - remin	trap	experimental	In Situ Microbial metabolism, sinking particles	In situ incubation chamber (RESPIRE) or trap particles	heterotrophic metabolism of sinking POC	1abd	2abcd	no	no	no	1	1, 1	no	no	8
41	Export - remin	CTD	experimental	Aggregation & disaggregation	Aggregation experiments	Controlled studies of aggregation/disaggregation rates by tracking particle size/nur	1c	2abc	no	no	no	1	1, 1	no	no	5
42	Optics- modeling	Multi	sensor	PAR, above-water and subsurface	PAR	Needed for productivity estimates, euphotic depth	1abcd		1- a; 1-b	1	no	1	no	1	1a, 1b, 2c	2
43	Optics- modeling	CTD	geochem	CDOM absorption	CDOM absorption spectrum.	inform remote sensing modeling. indicator of DOM remin.	1abd	2abcd	1- a	1	no	1	2, 2	1	no	9
44	Optics- modeling	CTD	geochem	Phytoplankton and detrital absorption sprectrum	absorption spectrum (Kishino method)	for input to optical models	1ab	2abc	1- a	1	2	1	no	no	no	9
45	Optics- modeling	CTD	sensor	Spectral particle absorption & attenuation	acs	inform remote sensing and provide phyto pigment proxy	1abcd	2abc	1- a; 2-b	1	no	1	no	no	no	9
46	Optics- modeling	CTD	sensor	Spectral particle attenuation	acs	inf										9
47	Optics- modeling	Multi	sensor	Particle size	Multiple-wavelength backscattering	sp										9
48	Optics- modeling	Multi	sensor	Remote sensing reflectance (subsurface obs)	Ed (l) & Lu (l)	Lin										9
49	Optics- modeling	ship	sensor	Water-leaving radiance (-->remote sensing reflectance) above water	Lw (l)	cr										9
50	Optics- modeling	ship	sensor	LIDAR	ship-mounted LIDAR	lin										9
51	Optics- particle proxy	Multi	sensor	Single wavelength beam c and bbp (ie 650 nm)	acs/C-Star/C-Rover, transmissometers	PO										4
52	Optics- particle proxy	CTD	sensor	Birefringent (calcite) particles	polarized beam c (WETLabs PIC/POC sensor)	characterization for birefringent (i.e. calcite-containing) particles.	1abcd		2- a	2	no	2	no	2	2a, 2b, 2c	8
53	Optics- particle proxy	ship	sensor	Particulate inorganic carbon	acid-labile backscattering	PIC proxy to interpret remote sensing obs. and refine backscatter proxy for POC	1abd	2abc	1- a	no	1	no	2	no	no	9
54	Optics- particle proxy	Multi	sensor	Flux derived from particle distributions	Backscattering sensors on autonomous platforms	Assessment of particle abundance changes over time	1ab	2abcd	no	no	2, 2	no	1, 1	no	1a, 1b, 2c	1
55	Optics- particle proxy	CTD	sensor/geochem	Total small particle size spectrum	e.g., Coulter Counter (bench), LISST (in situ) for small p	size spectrum, non living biomass, 0.1 - 1000 µm	1abcd	2abcd	no	2	1, 2	1	1, 1	no	no	5
56	Water- collect	CTD	Rosette & sensors	CTD- see also physical processes	CTD- O2, T/S	O2, temp., salinity, structure of water column; budgets for NCP (w/NO3)	1abcd	2abcd	no	1	1, 1	1	1, 1	1	1a, 1b, 1c	6
57	Water- Phyto	CTD	geochem	Chlorophyll fluorescence	in vivo chlorophyll fluorescence sensor	chlorophyll proxy when calibrated to pigment samples	1abcd	2abc	1- a; 1-b	1	2	1	2	1	1a, 1b, 1c	3
58	Water- Phyto	CTD	geochem	particle composition	HPLC pigments	phyto community; link with historical NASA measurements	1abcd	2abc	2-a	1	2	1	no	1	no	4
59	Water- Phyto	CTD	geochem	particle composition	Chlorophyll incl. some size fractionated	For calibration of chlorophyll fluorescence sensors	1abcd		1- a	1	no	1	no	1	no	7
60	Water- dissolved	CTD	geochem	Oxygen	O2 bottle (Winkler)	High precision Winkler on water samples, to calibrate O2 sensors	1abcd	2abc	no	1	2	2	2	1	no	2
61	Water- dissolved	CTD	geochem	Dissolved Inorganic Nitrogen, Phosphorous, Silicate	Frozen for later autoanalyzer	vertical profiles and integrated inventories of inorganic nutrients	1abd	2abcd	no	1	1, 2	1	1, 1	1	1a, 1b, 1c	6
62	Water- dissolved	CTD	geochem	DOM for export via physical mixing	DOM	mixing of DOM, modeling of export	1abd	2abcd	no	1	1, 2	2	2,2	1	no	1
63	Water- dissolved	CTD	optics	DOM source from fluorescence	Spectral fluorescence on discrete samples	indicator of DOM remineralization in the mesopelagic	1d	2abcd	no	2	2, 2	2	2, 2	1	no	6
64	Water- dissolved	CTD	geochem	Dissolved Organic Matter Characterization	DOM quality such as PAD-HPLC, High Resolution Mass	Insight into diagenetic state and lability of DOM	1abd	2abcd	no	2	2, 2	1	1, 1	no	no	6
65	Water- dissolved	CTD	geochem	Total Dissolved Nitrogen	High Temperatuture combustion of TDN.	TD										6
66	Water- dissolved	CTD	geochem	Carbonate System	e.g. TCO2, pCO2, Talkalinity, pH	Inc										2
67	Water- particles	CTD	geochem	particle composition	POC, PON of particles from bottles	ca										8
68	Water- particles	CTD	geochem	particle composition	biogeneic silica	dia										9
69	Water- particles	CTD	geochem	particle composition	PIC (particulate inorganic carbon)	co										9
70	Water- particles	CTD	geochem	particle composition	Lithogenic Si, Al	ma										9
71	Water- particles	CTD	geochem	Transparent Exopolymer Particles	Microsopy, Spectroscopy	TE										5
72	Physics	towed	sensor	Mesoscale circulation	Synoptic, repeated surveys of mesoscale fields with to	Me										6
73	Physics	towed	sensor	Submesocale surveys	Synoptic, repeated surveys of submesocale fields with	Ve										6
74	Physics	satellite	model	Atmospheric Forcing	Satellite remote sensing products. Wind velocity, surfa	At										6
75	Physics	sensor	model	Ship-based Atmospheric Forcing	Wind velocity, short- & long-wave radiation, RH, air te	ground-truth, and shorter temporal and spatial scales.	1d	2d	1- UW	no		1		2	no	6
76	Physics	satellite	model	Large-Scale Circulation	Geostrophic surface velocity from SSH (e.g. AVISO), sta	Large scale velocity fields for context, experiment planning (drift modeling)		2d	-	-		-		-	no	6
77	Physics	satellite	model	Mesoscale circulation	Geostrophic surface velocity from SSH (e.g. AVISO), sta	Mesocale circulation and strain fields. Scales of 10-100 km and days.	1d	2d	-	-		-		-	no	6
78	Physics	CTD/AUV	sensor	Mixing	Microstructure measurements (temperature and shea	Quantify diapycnal mixing	1d	2d	no	2	2	2	2	no	2a, 2b, 2c	6
79	Physics	Multi	sensor	Mesoscale circulation	Maps of mesoscale fields from combined floats, glider	Mesoscale horizontal and vertical transport, modulation of submesoscale variability	1d	2d	-	-		-		-	2a, 2b, 2c	6

Program element: Phyto/microplankton

Program element: Zooplankton

Program element: Export

Program element: Optics

Program element: Physics and bulk geochemistry

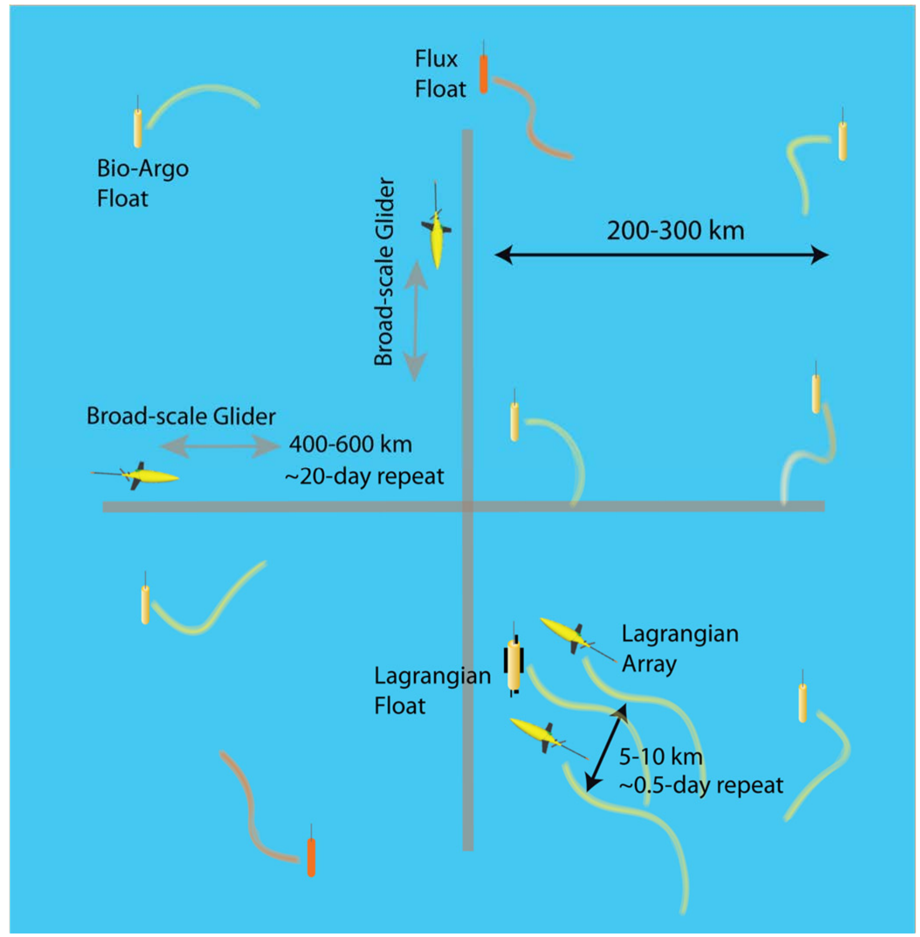
See also draft EXPORTS Implementation Plan, Section 4, Table 3

Leveraging ship-based sampling with autonomous platforms

What do we gain?

- Particulate organic carbon concentration and flux
- Chlorophyll
- Oxygen
- Nitrate
- pH
- Particle size
- Metrics for phytoplankton community composition
- Others in development…?

- e.g., NAB-08: 321 ship-based POC samples leveraged to give ~1.5M measurements on autonomous platforms!
- **Persistence** through full annual cycle
- Spatial and temporal **context** for cruises
- **Confidence** that data used to answer SQ3 are representative and capture all relevant scales



More details can be found in the draft EXPORTS Implementation Plan section 4.3

Sampling modes and platforms

Measurement priorities by SQ, platform and sampling mode:

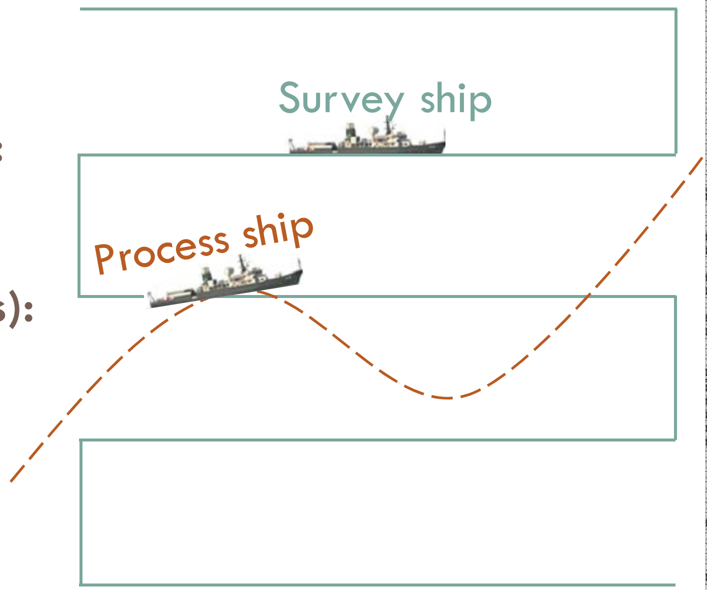
Platforms (ship & autonomous):

Process ship (Lagrangian)

Survey ship (distributed)

Autonomous platform deployment cruises

Autonomous platforms (floats, gliders)



Sampling mode (ship-based):

Profile, underway, towed

Sampling mode (autonomous):

Lagrangian, distributed

Section 3, draft EXPORTS Implementation Plan.

EXPORTS Notional Cruise Plan

Process Ship

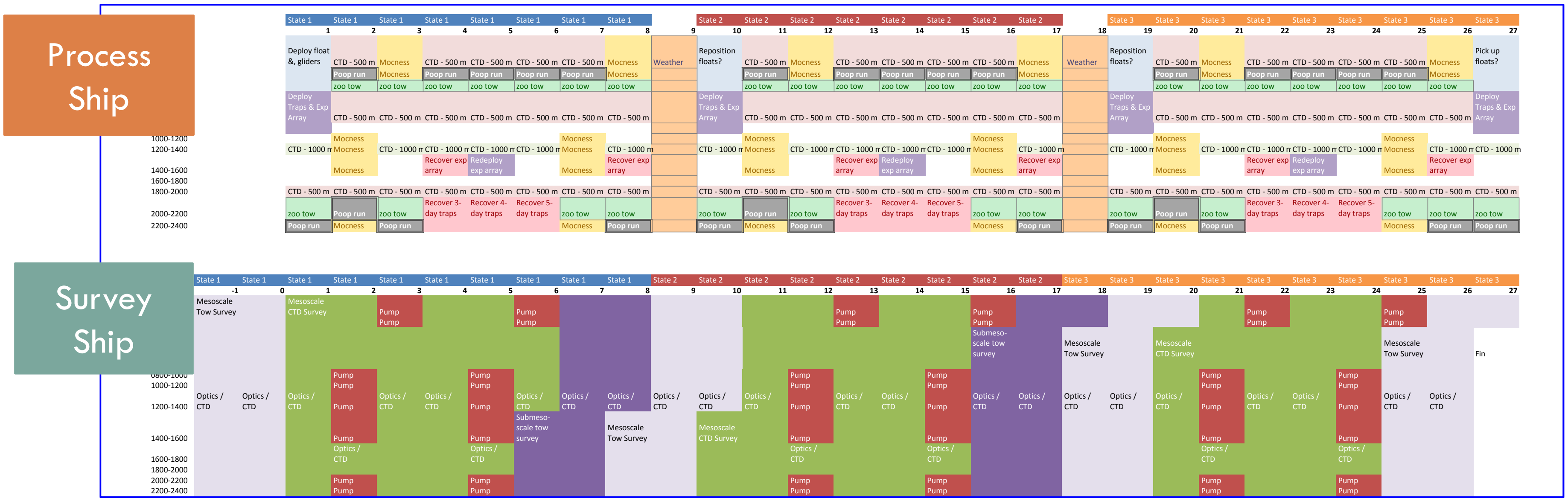
Process Ship	State 1	State 1	State 1	State 1	State 1	State 1	State 1	State 1		State 2	State 2	State 2	State 2
Day	1	2	3	4	5	6	7	8	9	10	11	12	
	Deploy float &, gliders									Reposition floats?			
0000-0200		CTD - 500 m	Mocness	CTD - 500 m	CTD - 500 m	CTD - 500 m	CTD - 500 m	Mocness	Weather		CTD - 500 m	Mocness	CTD -
0200-0400		Poop run	Mocness	Poop run	Poop run	Poop run	Poop run	Mocness			Poop run	Mocness	Poop r
0400-0600		zoo tow	zoo tow	zoo tow	zoo tow	zoo tow	zoo tow	zoo tow			zoo tow	zoo tow	zoo to
0600-0800	Deploy Traps & Exp Array	CTD - 500 m	CTD - 500 m	CTD - 500 m	CTD - 500 m	CTD - 500 m	CTD - 500 m	CTD - 500 m		Deploy Traps & Exp Array	CTD - 500 m	CTD - 500 m	CTD -
0800-1000													
1000-1200		Mocness					Mocness				Mocness		
1200-1400	CTD - 1000 m	Mocness	CTD - 1000 m	CTD - 1000 m	CTD - 1000 m	CTD - 1000 m	Mocness	CTD - 1000 m		CTD - 1000 m	Mocness	CTD - 1000 m	CTD -
1400-1600		Mocness		Recover exp array	Redeploy exp array		Mocness	Recover exp array			Mocness		Recov array
1600-1800													
1800-2000	CTD - 500 m	CTD - 500 m	CTD - 500 m	CTD - 500 m	CTD - 500 m	CTD - 500 m	CTD - 500 m	CTD - 500 m		CTD - 500 m	CTD - 500 m	CTD - 500 m	CTD -
2000-2200	zoo tow	Poop run	zoo tow	Recover 3-day traps	Recover 4-day traps	Recover 5-day traps	zoo tow	zoo tow		zoo tow	Poop run	zoo tow	Recov day tra
2200-2400	Poop run	Mocness	Poop run				Mocness	Poop run		Poop run	Mocness	Poop run	

Each ecosystem & carbon cycling state will take 8 days to sample

Survey Ship

Survey Ship	State 1	State 1	State 1	State 1	State 1	State 1	State 1	State 1	State 1	State 1	State 2	State 2	State 2	State 2	State 2
Day	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	
0000-0200	Mesoscale Tow Survey		Mesoscale CTD Survey		Pump			Pump							Pump
0200-0400					Pump			Pump							Pump
0400-0600															
0600-0800															
0800-1000				Pump			Pump							Pump	
1000-1200				Pump			Pump							Pump	
1200-1400	Optics / CTD	Optics / CTD	Optics / CTD	Pump	Optics / CTD	Optics / CTD	Pump	Optics / CTD	Optics / CTD	Optics / CTD	Optics / CTD	Optics / CTD	Optics / CTD	Pump	Optics CTD
1400-1600				Pump			Pump	Submeso-scale tow survey		Mesoscale Tow Survey		Mesoscale CTD Survey		Pump	
1600-1800				Optics / CTD			Optics / CTD							Optics / CTD	
1800-2000															
2000-2200				Pump			Pump							Pump	
2200-2400				Pump			Pump							Pump	

EXPORTS Notional Cruise Plan



- Three 8-day "state assessments" per cruise, which sets cruise durations of 27 days on site
- Maps sampling activities onto each ship & considers measurement interdependencies
- ~60 berths available – The Goal Plan fits!!

See also: draft EXPORTS Implementation Plan section 4.2 and 7.3

EXPORTS Observing System Timeline

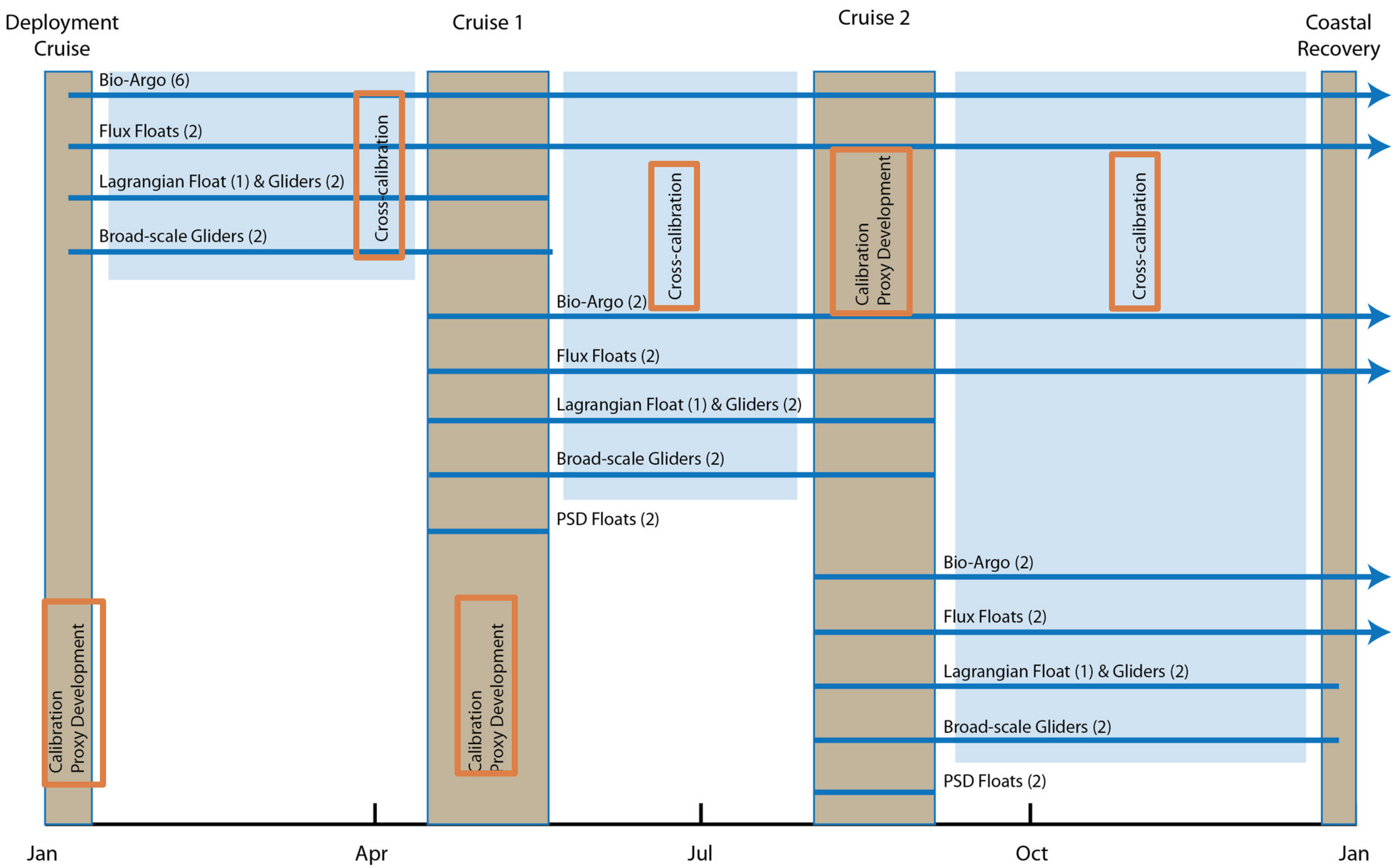
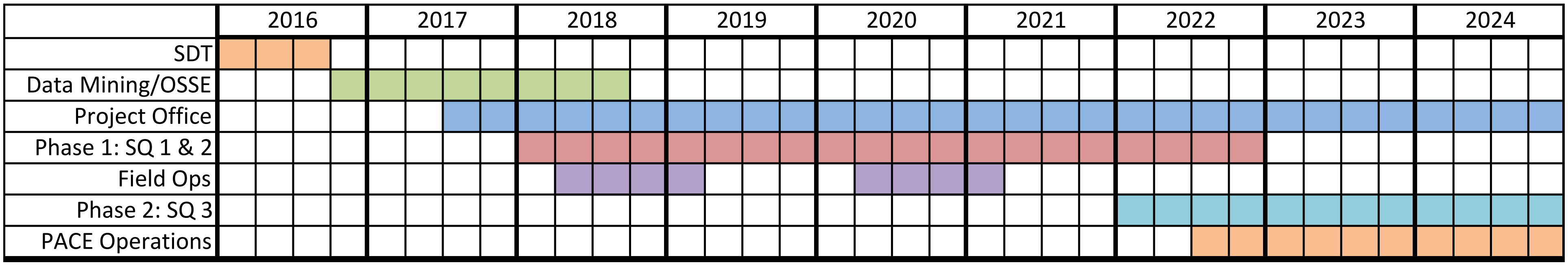


Figure 4, draft EXPORTS Implementation Plan. See also section 4.3

Suggested timeline for Goal Plan implementation



- Two-phase implementation
- Phase 1: Field operations, answer SQ1 and SQ2
- Phase 2 : Modeling & synthesis to answer SQ3

Figure 2, draft EXPORTS Implementation Plan. Also see section 4.1

Suggested management structure

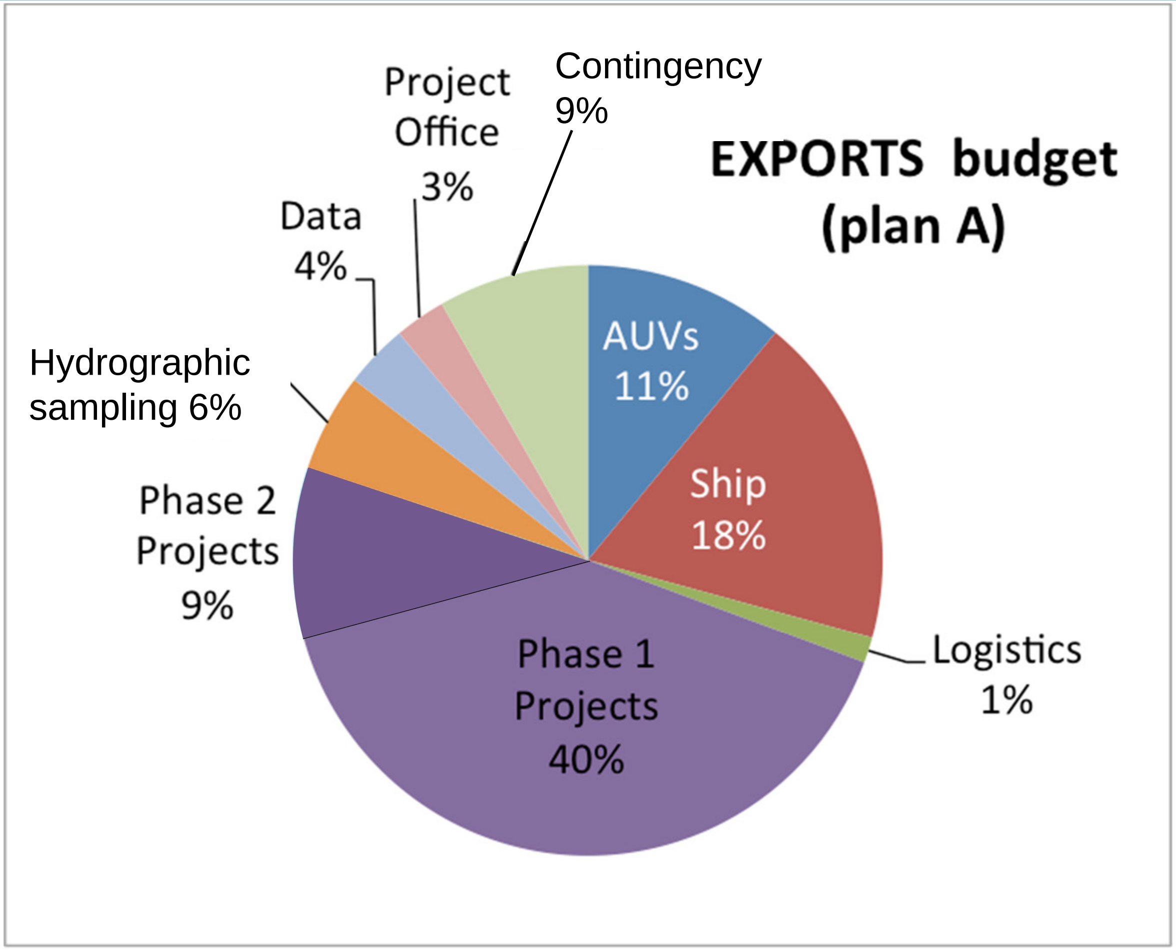
- Central project office for 7-year duration
- Lead scientist and deputy lead scientist
- Science steering committee
- Leadership team members represent all primary research areas
- Staggered turnover among leadership team members

Section 4.6, draft EXPORTS Implementation Plan.

Talk outline

- How did we come up with the goal plan?
- Highlights of the goal plan
- **Cost estimate for the goal plan**
- Alternatives to the goal plan, to fit different budget scenarios

Goal plan = $71.5M over 7 years

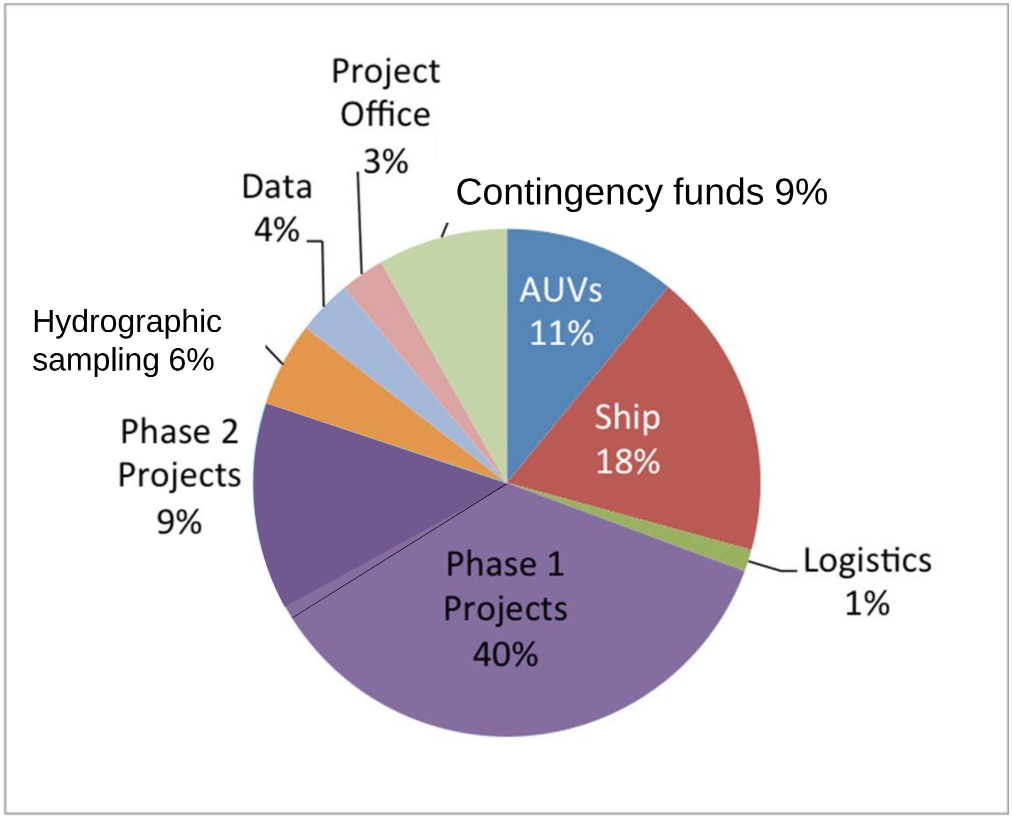


See EXPORTS Implementation Plan, section 5.1 and supplementary budget spreadsheet, section 7.5

Goal plan = $71.5M over 7 years

Biggest pie slices

- PI projects: 23 in Phase 1, 8 in Phase 2
  - Section 4.1, Table 3
- 338 ship days:
  2 x 2-ship cruises in each of 2 oceans
  - Section 4.2
- Autonomous sampling operation
  - Section 4.3



See EXPORTS Implementation Plan, section 5.1 and supplementary budget spreadsheet, section 7.5

Talk outline

- How did we come up with the goal plan?
- Highlights of the goal plan
- Cost estimate for the goal plan
- **Alternatives to the goal plan, to fit different budget scenarios**

What are the tradeoffs between cost and science return?

Other Implementation Options

	Cruises	Basins	Ships	Projects in Phases 1 & 2	Years	Sea Days	Total Cost
A: Goal Plan	4	2	2	23 / 8	7	338	$72M
B: Goal "Lite"	4	2	2	20 / 6	7	338	$62M
C: Full Plan but 1 ship	4	2	1	18 / 8	7	196	$57M
D: 3 cruise, 1 basin, 2 ships	3	1	2	23 / 8	7	263	$58M
E: 2 cruise, 1 basin, 2 ships	2	1	2	23 / 0	5	164	$39M
F: 2 cruise, 1 basin, 1 ship	2	1	1	18 / 0	5	95	$30M
G: 1 cruise, 1 basin, 1 ship	1	1	1	18 / 0	4	50	$22M

No Phase 2…

Table 5. See also section 5.2.

Resources & costs adjusted by total effort …

Evaluating other implementation options

How globally representative will our observations be?

Will we be able to fully constrain all 5 export pathways?

Other options reduce costs but add risks, relative to Goal Plan

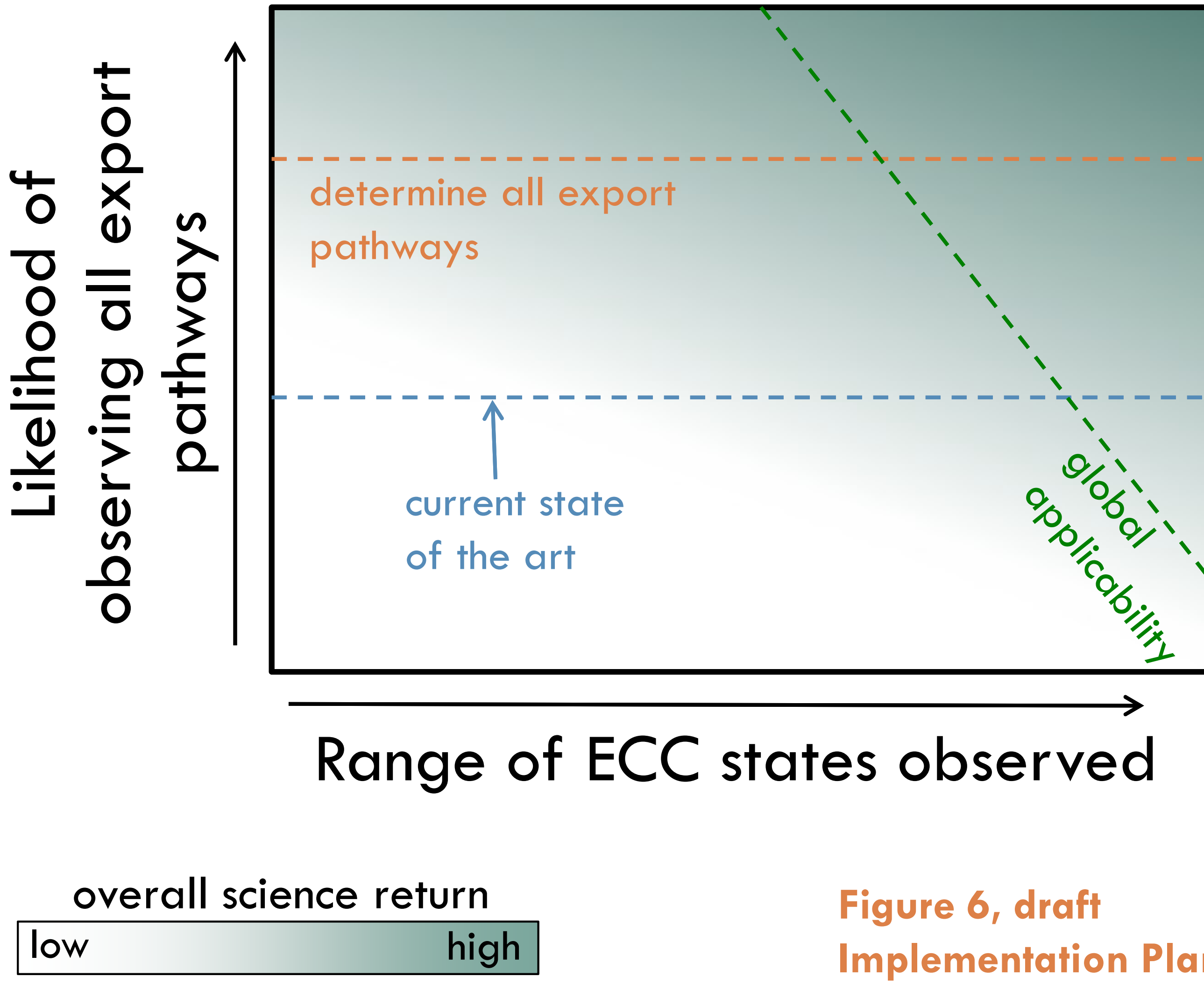


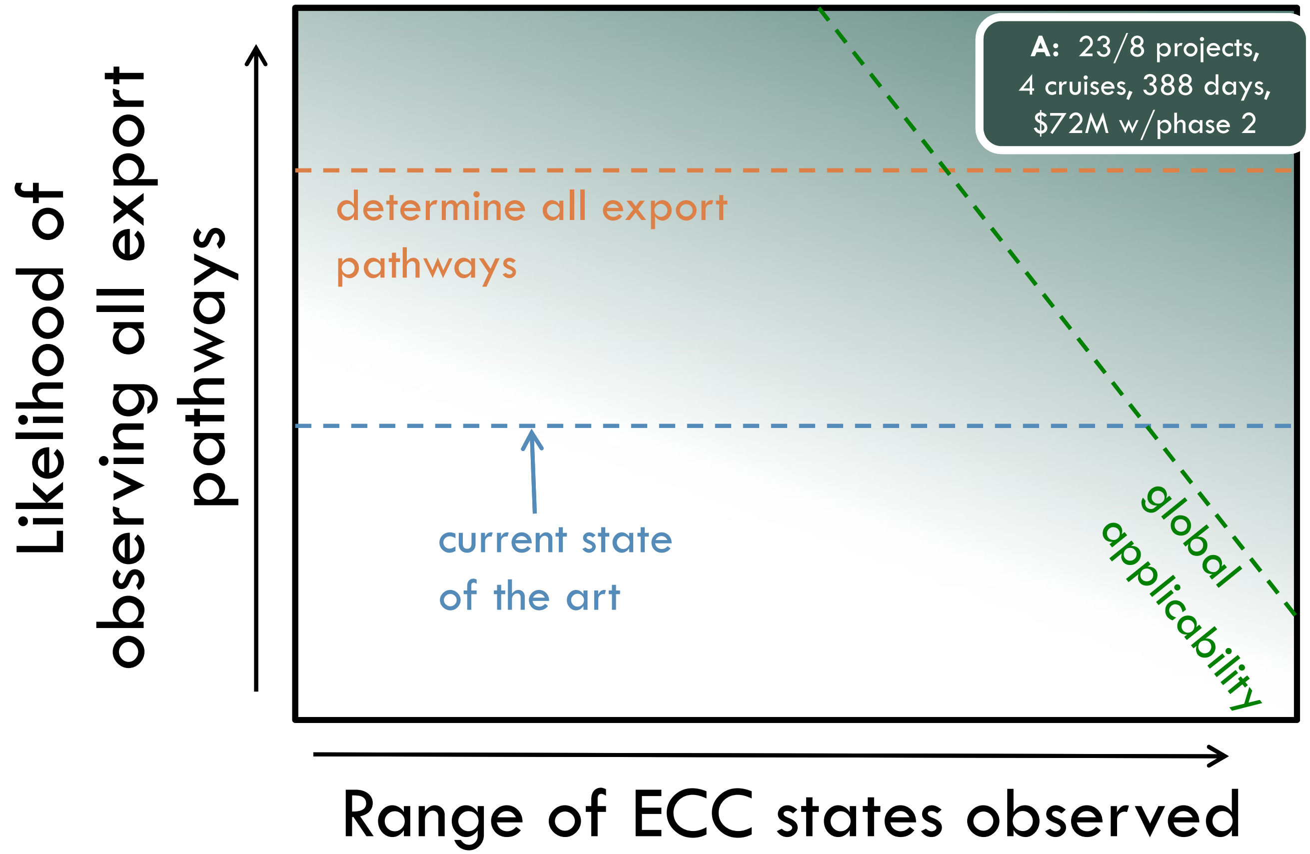
Figure 6, draft Implementation Plan

Plan A (Goal Plan)

Goal plan minimizes the risk of not answering all science questions

All pathways, 12 ECC states (3 per cruise) sampled

Includes "innovation" projects and "Phase 2" to answer SQ 3



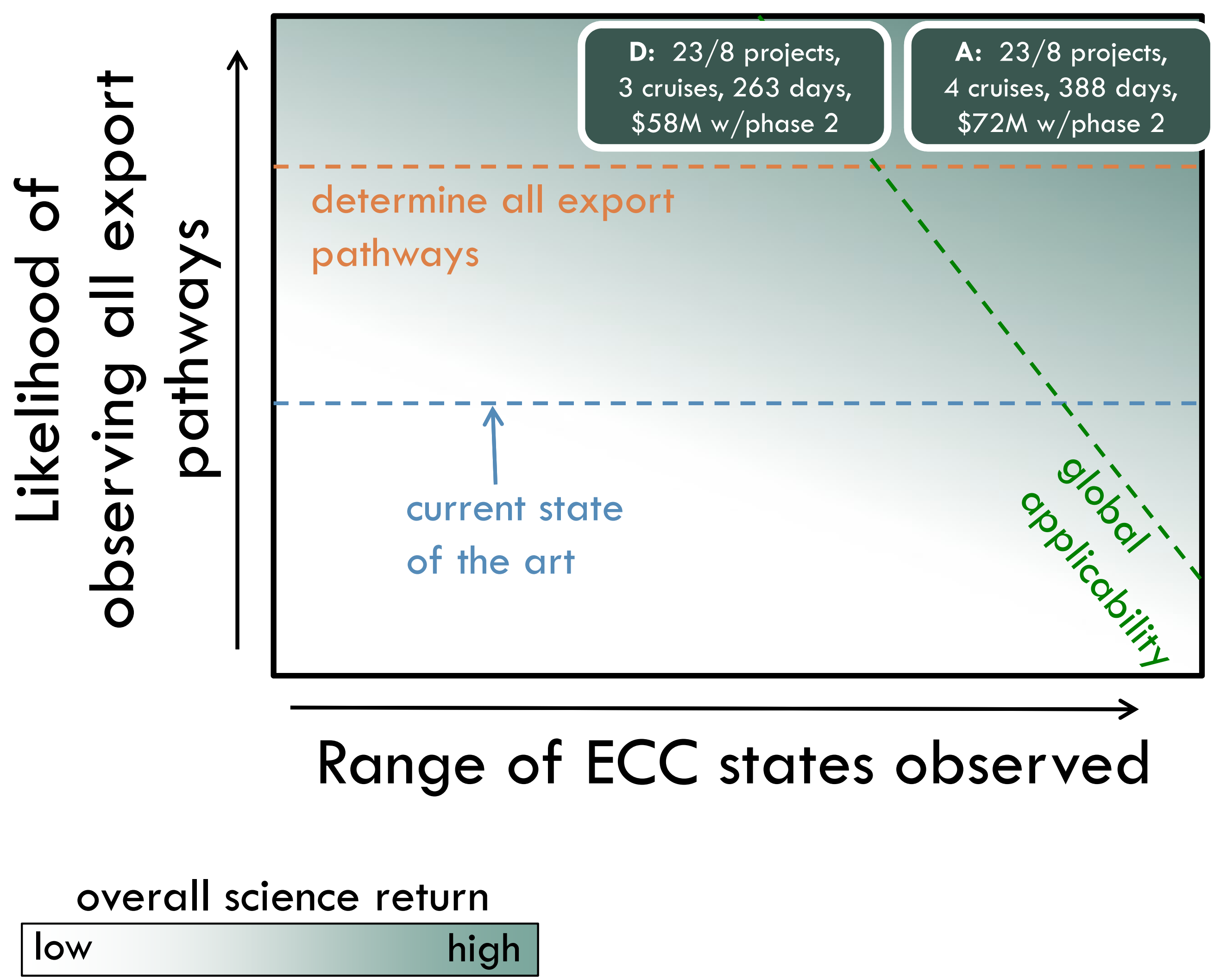
Plan D (3 cruises / 1 basin)

All pathways, 9 states (3 per cruise)

No innovation projects

Impacts ability to constrain program elements & pathways and answers to SQ 1 & 2

Increases risks for SQ3 increasing the dependence on data mining



Plan F (2 cruises / 1 basin / 1 ship)

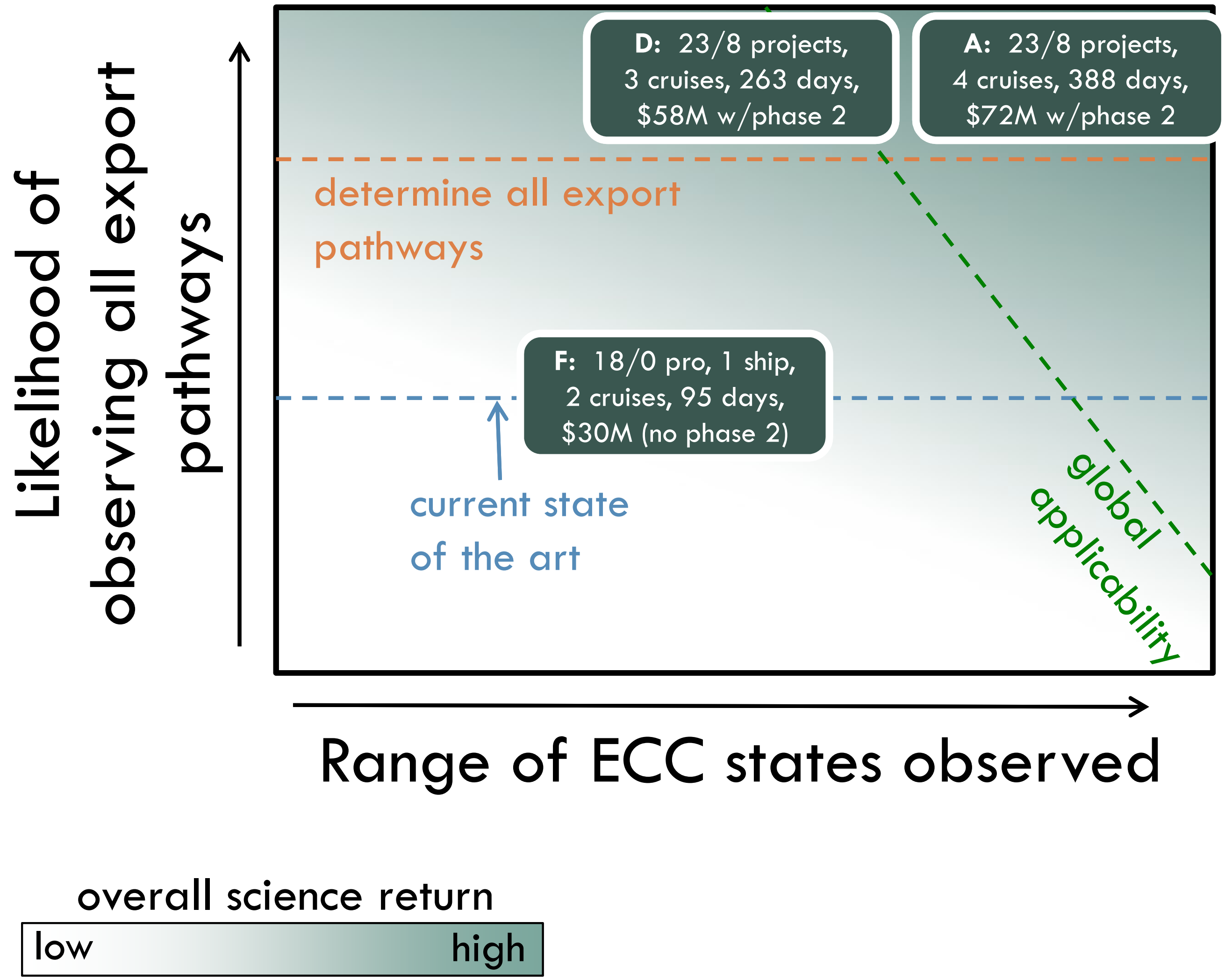
Lose physics pathway

Fewer states (max = 6)

No innovation projects

May not allow "Phase 2"

Severely impacts ability to constrain program elements, pathways, and answers to SQ 1 & 2



Evaluating other implementation options

How globally representative will our observations be?

Will we be able to fully constrain all 5 export pathways?

Other options reduce costs but add risks, relative to Goal Plan

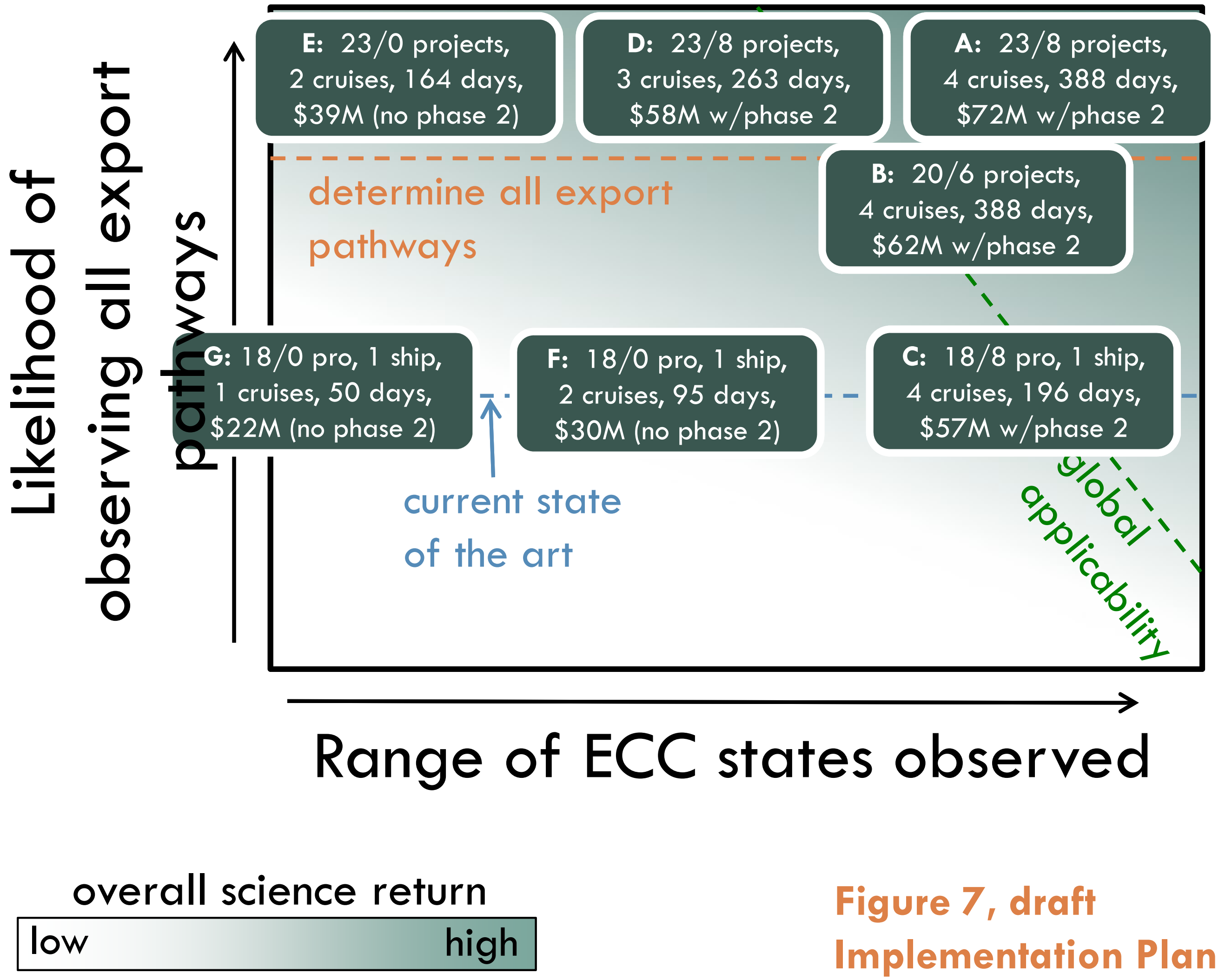


Figure 7, draft Implementation Plan

Program Challenges

Striking balance among discovery, innovation, broad participation, agency mission & cost

Supporting coordination among competed projects to insure a complete measurement set

Developing effective partnerships with national agencies and international entities

Insure that Phase 2 occurs so that improvements to C cycle satellite algorithms & models are made

Thank You for Your Attention!!

EXPORTS SDT: Dave Siegel (Lead; UCSB), Barney Balch (Bigelow), Mike Behrenfeld (OSU), Ken Buesseler (WHOI), Craig Carlson (UCSB), Nicolas Cassar (Duke), Ivona Cetinic (NASA GSFC). Scott Doney (WHOI), Meg Estapa (Skidmore), Bethany Jenkins (URI), Ken Johnson (MBARI), Craig Lee (UW APL), Adrian Martin (SOC), Susanne Menden-Deuer (URI), Roo Nicholson (WHOI), Uta Passow (UCSB), Mary Jane Perry (UMaine), Natassa Romanou (NASA GISS), Deb Steinberg (VIMS), Andy Thompson (CalTech) & Jeremy Werdell (NASA GSFC). Ex officio: Paula Bontempi (NASA HQ), Quincy Allison (NASA ESPO), Peter Griffith (NASA GSFC) & Mike Sieracki (NSF)

Thank you to our colleagues who have provided 100's of comments on the draft EXPORTS Science Plan

Next steps

- EXPORTS does not yet exist as a program! This will require broad community support, input, and enthusiasm expressed *here*, and to agency leaders.
- If EXPORTS moves forward, this community will carry it out and its implementation will reflect your ideas.

Share your questions and comments on the draft Implementation Plan

- Right now, during group discussion
- Watching the webstream? Live email: ocb_live@whoi.edu
- Early career? At lunch today, look for EXPORTS tables (#1-6)
- Email to: obb_comments@cce.nasa.gov, by Sept. 1

- How might the Goal Plan be improved, to better answer the science questions?
- Where are there gaps in the planning?
- In choosing between implementation options, which risks are easiest to accept, and which science is the most valuable? Which implementation option strikes the best balance?
- What is the number one science priority for the implementation plan?
- With whom might we partner internationally?
- How can the suggested management structure be more effective?
- Should the proposed implementation timeline or geographic sampling strategy be altered?
- Are there implementation options we ought to have considered more closely?
- How can we best foster collaboration & organization among program participants to achieve science goals?

Share your questions and comments on the draft Implementation Plan

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EXTRAS

Science Plan in a nutshell

Goal: Predict the export and fate of ocean NPP from satellite & other observations

Approach: Compare observations over a range of ecosystem / C cycling states (incl. data mined results)

Modularity: Focus on assessing “states” creates flexibility for de/rescoping & partnering

Vetting: Science Plan underwent two community comment periods & peer review panel

Science Plan: http://cce.nasa.gov/obb/exports.html

(also Siegel et al. *Frontiers in Marine Science*, 2016)

Organizing it all: Goal Plan Implementation