Project Number: 901304

Project Start: Jan. 1, 2013 **Project Duration (in years): 2**

Please indicate what type of project is being proposed (mark only one).

[X]	[ ]	[ ]	[ ]	[ ]
Feasibility/Scoping [Less than 100 days effort]	**Development**[1]	**Research**	**Infrastructure**[2]	**Education**

[ ]	[ ]
Time Series	**Institute Initiative**

Project Manager[2]: Ken Smith

Principal Investigators: Francisco Chavez, Bruce Robison, Ken Smith

Lead Scientists: All the above

Lead Engineer: Alana Sherman, Kevin Gomes

Project Title: An integrated MBARI time-series program

[1] Development and infrastructure projects must complete the risk matrix (see item #5 at the end of the proposal form).
[2] Not all projects will require all four titles to be filled in. Please indicate individuals only for those titles that are appropriate for your project.

1) ABSTRACT (new projects only)

[Paste abstract here]

2) PROPOSAL

a) New Projects

Statement of the problem, why it is important

[Click here to enter text]

How does it relate/contribute to MBARI's mission and strategic plan?

[Click here to enter text]

How does it relate/contribute to the Packard Foundation's Ocean Visions Grantmaking policies?
(See http://mww.mbari.org/oed/OED_Documents3.htm#Packard for documents.)

[Click here to enter text]

Approach to the problem

[Click here to enter text]

Publications (from other projects over the last 5 years)

[Click here to enter text]

b) Continuing Projects

Presently there are three independent long time-series projects being conducted at MBARI:
 The Monterey Bay Time-Series project is focused on the upper water column and collects data from multiple sites, relying on hydrocasts, moorings, AUVs/gliders, satellites and models.
 The Midwater Time-Series project collects data from mid-depths in Monterey Bay, using video transects by ROVs.
 The Pelagic-Benthic Coupling project collects data from the water column/benthic interface, using free-vehicle sediment traps and cameras, Benthic Rover, and ROVs.

For 2013, we proposed a feasibility and scoping project to determine if we can integrate these three efforts and develop a collaborative database. Each project is presently focused on a different habitat and each employs different technologies, but together they cover the predominant oceanic habitats of the region (Figure 1), from surface to benthos. In the first seven months of this project we have explored options for scientific coordination and technology development between the three projects. Our primary

goals have been to add value to the scientific and technological impacts of our time-series projects through increased data accessibility and widespread standardization of measures and data products, while also increasing efficiency and reducing costs.

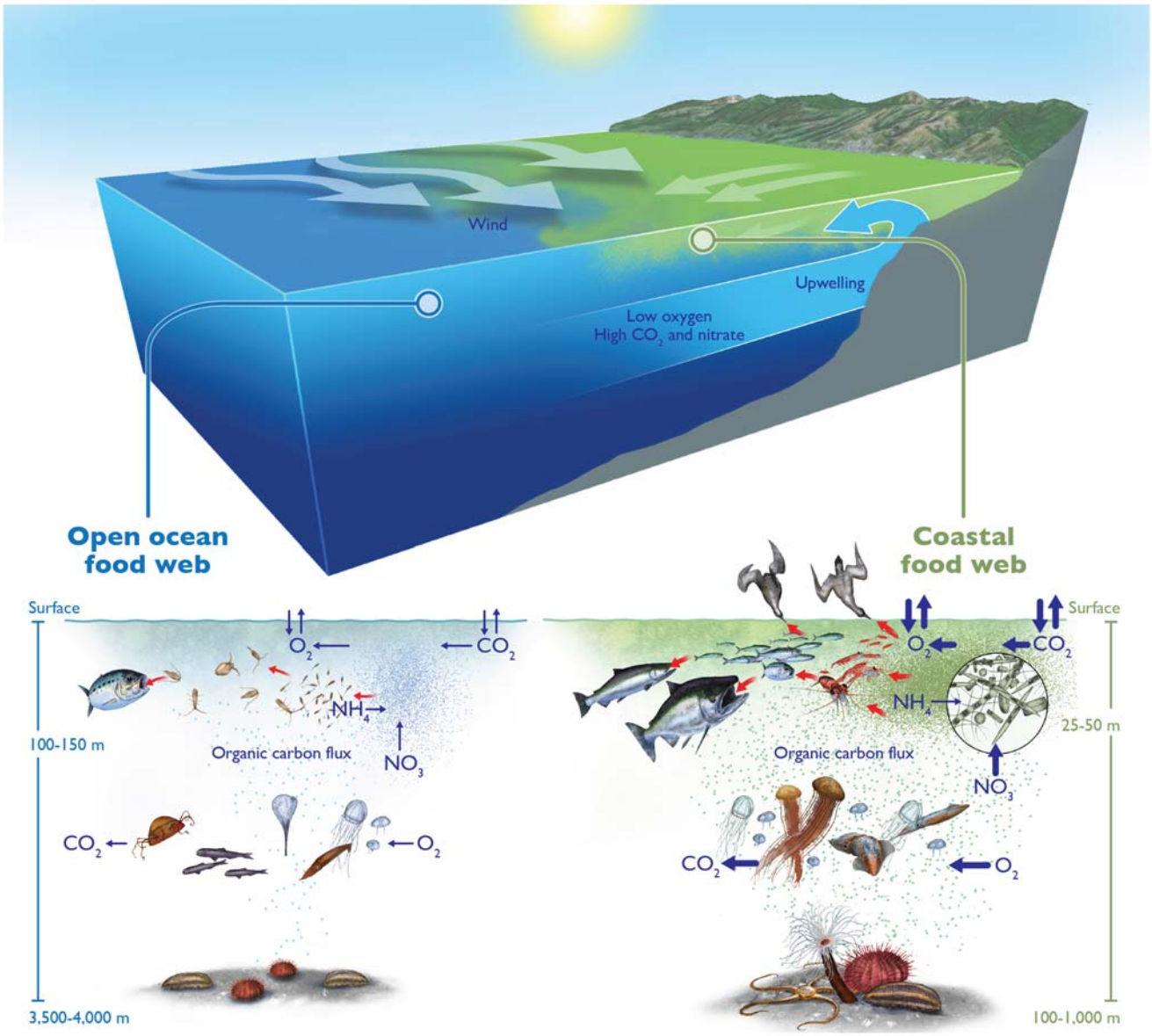


Figure 1. Predominant oceanic conditions and carbon exchanges in coastal California.

Current status of project and results to date

We have had monthly meetings since January to discuss the integration of the three time series projects with the following results to date:

1. Principal investigators agree to continue to occupy two time series stations in the future. A) A station representative of Monterey Bay in the vicinity of M-1 and Midwater #1, the location of

which may also be influenced by the position of a MARS extension. B) Sta. M to represent the off-shore region of the California Current. Figure 1 depicts the ecosystem at both stations.

2. Merged data sets show similar trends from surface waters to abyssal depths over the 24-yr time series at both Sta. M-1/Midwater#1 and M. The surface water temperature anomaly shows significant cooling events since 2000 with increasing surface chlorophyll and decreasing dissolved oxygen (Fig. 2A,B,C). From 2002 to 2010, there was a major increase in *Dosidicus gigas* sightings in midwater (Fig. 2D). At abyssal depths the particulate organic carbon (POC) flux has significantly increased reaching major peaks in 2011-2012, the largest documented thus far at Sta. M (Fig. 2E).
3. Kevin Gomes has been integrating the existing data products from each of the three time-series projects. These parameters are summarized in Figure 3 with a more detailed flow sheet shown separately (Appendix, Fig. 1).
4. Alana Sherman and Brett Hobson have generated a table of measurements and currently employed instrumentation for each time series (Table 1). Together, we are working toward refining this table to integrate the time-series measurements at two stations, and identify the needed platforms and sensors envisioned in the future. Alignment with the Technology Roadmap is a key goal of this process.

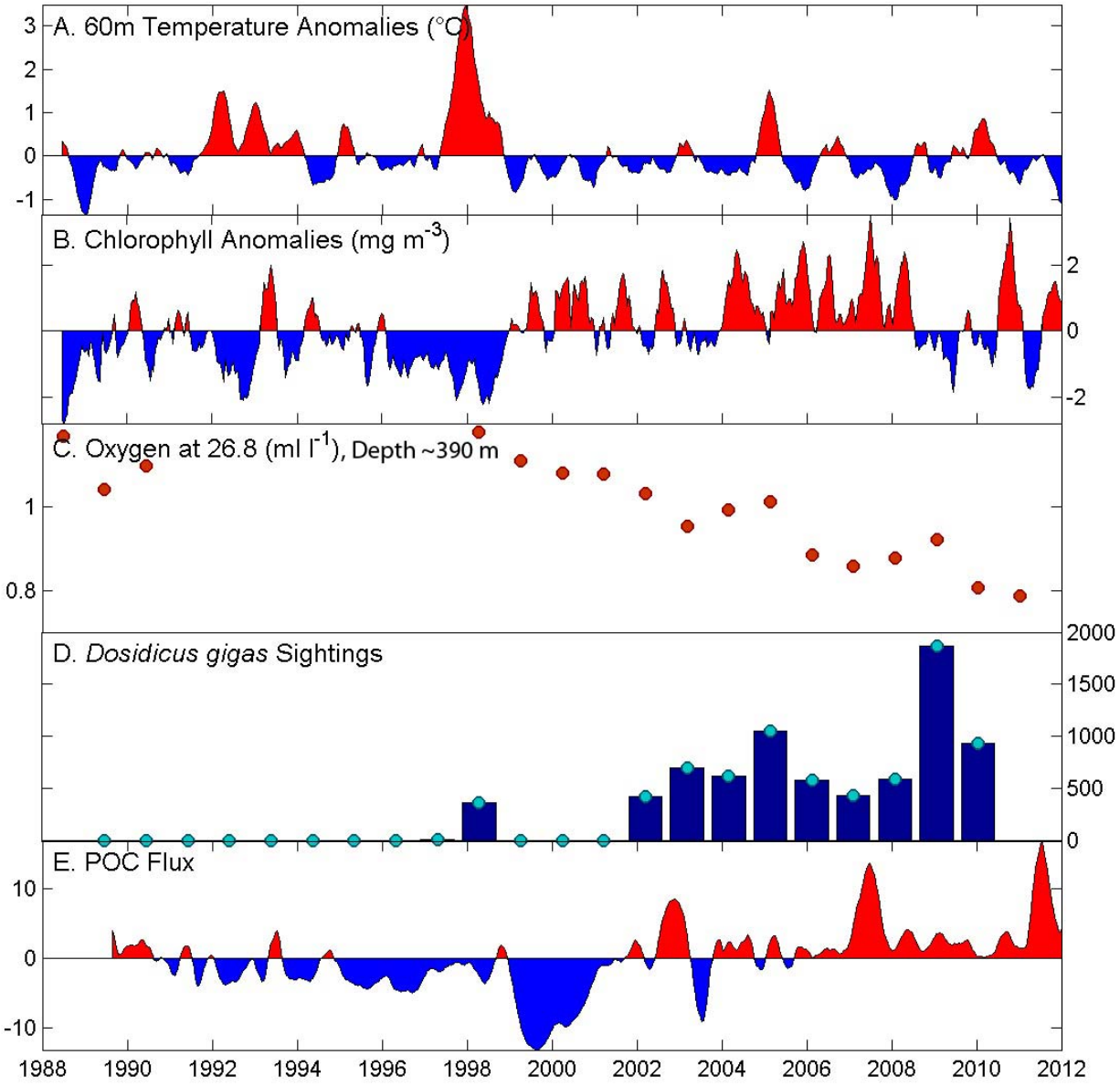


Figure 2. Integration of long-term time series data from surface to the deep-sea.

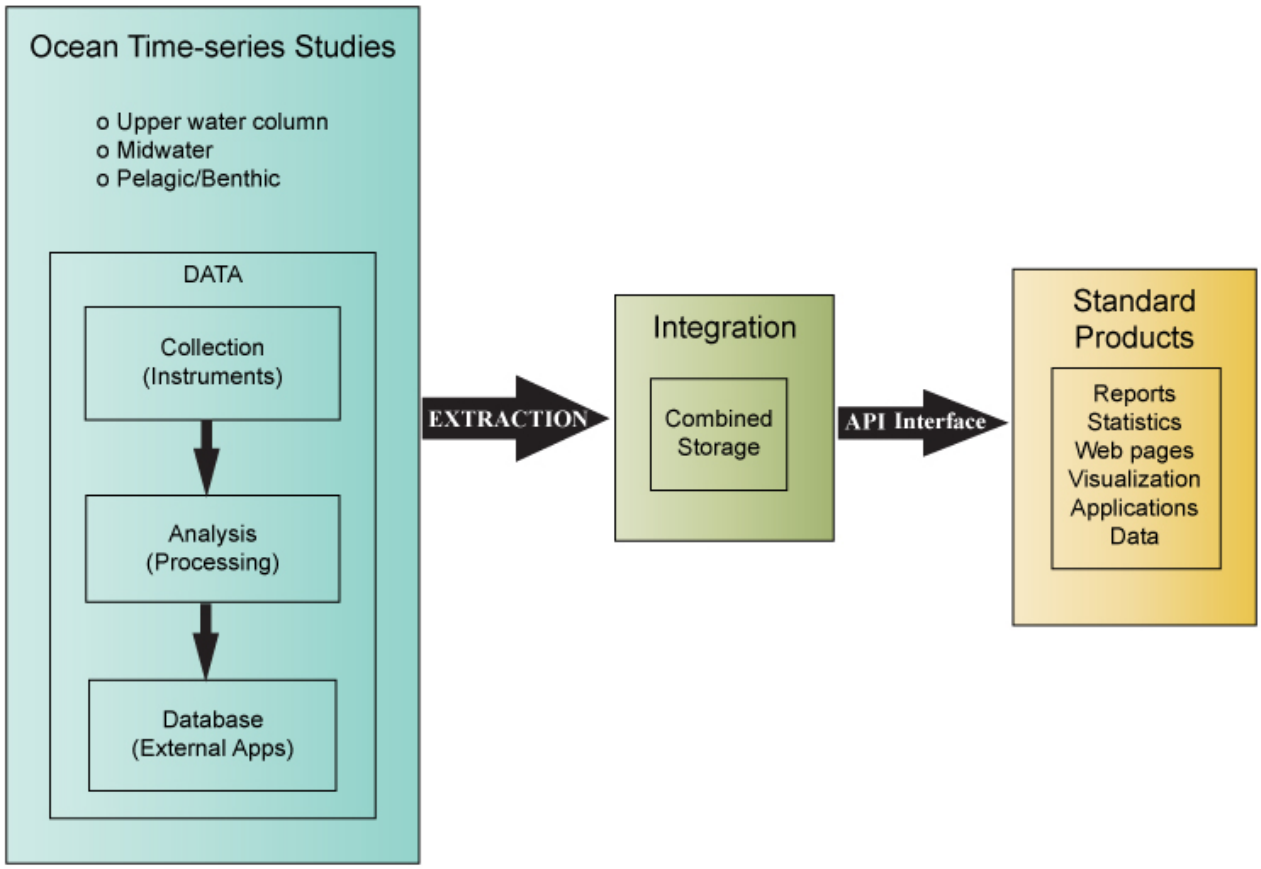


Figure 3. Schematic of time-series data integration. See appendix, figure 1 for details.

Significant changes from previous project proposal

None

Publications based on the results of this project only

None to date

c) New and Continuing Projects: Plans for 2014

Research Activities

1. Complete the integration of existing data sets from the three time-series projects.

2. Identify the representative measurements needed to continue the time-series studies at both Sta. M-1/Midwater #1 and M.
3. Identify the sensors and platforms needed to carry out time-series measurements at both stations over the next 3 to 5 year and 5 to 10 year periods in concert with the projected technology in the Tech Roadmap, and projects such as i2Map and the VPC which are already underway.
4. Prepare a manuscript describing the integrated time-series data sets, and demonstrating how such studies are critical to understanding climate change impacts on marine ecosystems, from surface waters to the seafloor. We plan to submit this manuscript to a peer-reviewed journal.
5. Develop the integrated time series study with the vision of exporting the technology to other scientists, allowing them to replicate these studies in other areas of the world ocean.
6. Conduct a "synoptic" pilot survey of both stations using existing sensors on the LRAUV to measure upper water column parameters. We propose to conduct this survey in January-February 2014 as a proof-of-concept exercise to interrogate the Rover and SES at Sta. M for status reports. We aim to use these results as part of a full integrated time-series proposal to be submitted for 2015. The cost of operating the LRAUV, using a wave glider for towing out to Sta. M, has been added to the Pelagic-Benthic proposal (#901113).

Engineering/technology development

We have found this study is best represented by integration of engineering and science objectives (see above).

Field programs (detail ship requirements/deployments/diver requirements)

Conduct a "synoptic" survey of both stations using the LRAUV to measure upper water column parameters with existing sensors and interrogate Rover and SES for status reports at Sta. M. This survey will also be used for comparative measurements with Ken Johnson's long-term float in the vicinity of Sta. M, collecting chlorophyll and nitrate data. We propose to conduct this survey in January-February 2014 as a proof-of-concept so that the results could be generated for use in a full integrated time-series proposal for 2015. The cost of operating the LRAUV with towing out to Sta. M by a wave glider, has been added to the Pelagic-Benthic proposal.

Specific deliverables

Integrated approach to time-series studies at MBARI documented in manuscript to be published in refereed journal

Milestones (see personnel classification list)
Requested engineering time follows the limitations set by the MT for our 2013 project.

2014 Project Start Date: MM/DD/2014	**Milestone 1**	**Milestone 2**	**Milestone 3**	**Milestone 4**	**Milestone 5**	**Total Resources[3]** for each resource category for all milestones listed here
Milestone Date	**Spring - 2014**	**Spring - 2014**	**Spring - 2014**	**Fall - 2014**	**Winter - 2014**	
Milestone Description	**Research Activity #1**	**Research Activity #2**	**Research Activity #3**	**Research Activity #4, #5**	**Research Activity #6**	
EE			**A.S. 20**	**A.S. 5**	**A.S. 15**	**40**
SE	**K.G. 60**	**K.G. 60**	**K.G. 60**	**K.G. 60**	**K.G. 56**	**296**
ME			**B.H. 20**	**B.H. 5**	**B.H. 15**	**40**
EE Tech						
SE Tech						
ME Tech						
Machine Shop						
Divers						

Budget justification

No funding requested

Project team

Francisco Chavez, Bruce Robison, Ken Smith, Alana Sherman, Kevin Gomes, Brett Hobson, Crissy Huffard, Rob Sherlock, Tim Pennington, Reiko Michisaki

Project lab space

None required

Data availability outside project team, uniqueness

The final publication in a peer reviewed journal will present an organized overview of the datasets being generated by this project. Data requests by external researchers can be evaluated on a case-by-case basis in accordance with MBARI policy. The integrated database will allow data to be extracted and summarized easily for sharing as appropriate.

[3] This number should be the same number you entered on the resource requests for this particular resource.

Export Regulation
None

Monterey Bay National Marine Sanctuary SESAs (General map)
Projects will need to indicate whether or not work will be conducted within one of the Monterey Bay National Marine Sanctuary's Ecologically Significant Areas (SESAs). An interactive map can be found on the Sanctuary's SIMoN webpages at http://sanctuarysimon.org/maps/sesa/. (*Note: It may take a moment for the page to load, so please be patient.*) To determine if your work will occur in a SESA, specific coordinates can be entered using the locator function (click on the red "target" button in the toolbar at the top of the map). If your work will be conducted in one of these areas, please indicate which area, by number.

None

Risk matrix (development and infrastructure projects only)

	Technical Risk	Organizational Risk	Tech Transfer Risk	Labor Estimate Risk
High				
Medium				
Low	X	X	X	X

Table 1. Current and proposed parameters measured for integrated time-series

Parameter	Approximate depth	Instrument	Platform today
Beam Attenuation	**0m**	Chelsea/Seatech/Wetlab Cstar	**Ship, Underway**
Beam Attenuation	**0m to 1000m**	CTD: Chelsea/Seatech/Wetlab Cstar	**Ship Cast**
Chla	**0m**	WetStar/SeaTech/Turner	**Ship, Underway**
Chla	**0m to 1000m**	CTD: Fluorescence, Wetlab ECO-AFL/FL	**Ship Cast**
Chlorophyll	**0m to 1000m**	Water samples: Turner Fluorometer	**Ship Cast**
Chlorophyll	**3950 m**	SES: fluorescence, image	**Mooring**
Chlorophyll	**4000m**	Rover fluorescence	**Benthic Rover**
Conductivity	**0m**	SBE	**Ship, Underway**
Conductivity	**0m to 1000m**	CTD: SBE	**Ship Cast**
Density	**0m to 1000m**	CTD: SBE	**Ship Cast**
Faunal communities	**50-1000m (ROV transects)**	HD, color video	**ROV**
Faunal communities	**4000m (time lapse)**	moored time lapse camera	**Mooring**
Faunal communities	**4000m (ROV transects)**	HD, color video	**ROV**
Fluorescence	**0m**	WetStar/SeaTech/Turner	**Ship, Underway**
Fluorescence	**0m to 1000m**	CTD: Fluorescence, Wetlab ECO-AFL/FL	**Ship Cast**
Nutrients	**0m to 1000m**	Water samples: AlpChem autoanalyzer	**Ship Cast**

Oxygen	**0m to 1000m**	CTD: SBE	**Ship Cast**
Oxygen	**0m to 1000m**	Water samples	**Ship Cast**
Oxygen	**50-1000m, 1000m**	ROV, CTDO	**ROV**
Particulate CHN	**4950 and 3400m**	Sediment traps	**Mooring**
Particulate organic matter	**51 and 600 mab**	SES	**Mooring**
pH	**0m**	Durafet II	**Ship, Underway**
Phytoplankton	**0m to 1000m**	CTD: Epifluorescence Microscopy	**Ship Cast**
Phytoplankton	**4950 and 3400m**	Sediment traps, microscopy, SES	**Mooring**
Primary Production	**0m to 1000m**	Water samples: Beckman LS-3801 liquid scintillation counter	**Ship Cast**
Salinity	**0m**	SBE	**Ship, Underway**
Salinity	**0m to 1000m**	CTD: SBE	**Ship Cast**
Salinity	**50-1000m, 4000m**	ROV, CTDO	**ROV**
Sediment CHN, chlorophyll	**4000m**	Sediment cores	**ROV**
Sediment community O2 use	**4000m**	Benthic Rover transect	**Benthic Rover**
TCO2	**0m**	Licor 820	**Ship, Underway**
TCO2/Alkalinity	**0m to 1000m**	CTD: Licor 820	**Ship Cast**
Temperature	**0m**	SBE	**Ship, Underway**
Temperature	**0m to 1000m**	ROV,CTDO	**ROV**
Transmissivity	**0m**	Chelsea/Seatech/Wetlab Cstar	**Ship, Underway**
Transmissivity	**0m to 1000m**	CTD: Chelsea/Seatech/Wetlab Cstar	**Ship Cast,ROVt**
Zooplankton (cms)	**50-1000m**	HD, color video	**ROV**
Zooplankton (microns - cms)	**0-100m, 100m intervals to 1000m**	Vertical camera profiler, acoustic profiler, Holo camera	**Ship Cast/AUV**

Table 1 ctd.

Platform Start of Time Series Project	**Platform 3- 5 yr into project**	**Ultimate platform**
wave glider?	**Wave glider**	Wave glider
ship cast/AUV Gulper (in shore)	**Vertical profiler/AUV**	Energy harvesting verticle profiler
wave glider?	**Wave glider**	Wave glider
ship cast/AUV Gulper (in shore)	**Vertical profiler/AUV**	Energy harvesting verticle profiler
ship cast/AUV Gulper (in shore)	**LRAUV water sampler**	In situ measurement
Mooring	**Mooring**	Mooring
Benthic Rover	**Extended Benthic Rover**	Extended Benthic Rover
wave glider?	**Wave glider**	Wave glider
ship cast/AUV Gulper (in shore)	**Vertical profiler/AUV**	Energy harvesting verticle profiler
ship cast/AUV Gulper (in shore)	**Vertical profiler/AUV**	Energy harvesting verticle profiler
i2map	**i2map on AUV3**	i2map on AUV3
Time Lapse Camera	**Time Lapse Camera**	AUV serviceable Time-lapse camera
ROV	**Benthic Imaging on AUV3**	Benthic Imaging on AUV3
wave glider?	**Wave glider**	Wave glider
ship cast/AUV (in shore)	**Vertical profiler/AUV**	Energy harvesting verticle prfiler

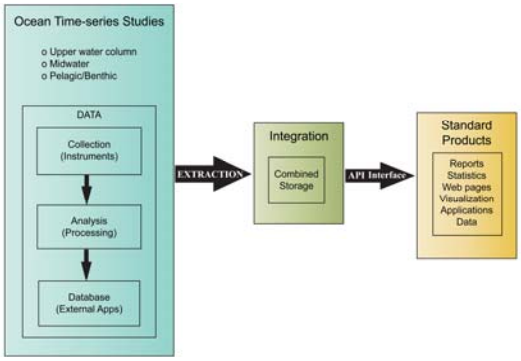
ship cast/AUV Gulper (in shore)	**LRAUV water sampler**	In situ measurement
ship cast/AUV Gulper (in shore)	**Vertical profiler/AUV**	Energy harvesting verticle prfiler
ship cast/AUV Gulper (in shore)	**LRAUV water sampler**	In situ measurement
ROV	**Dorado,0-1000m**	LRAUV deep
Mooring	**Mooring- extended deployment?**	In situ Carbon measurement
SES	**SES upgraded**	SES upgraded
Mooring	**Wave glider**	Wave glider
ship cast/AUV Gulper (in shore)	**LRAUV water sampler**	In situ measurement
Mooring	**Mooring**	Mooring
ship cast/AUV Gulper (in shore)	**LRAUV water sampler**	In situ measurement
Mooring	**Wave glider**	Wave glider
ship cast/AUV Gulper (in shore)	**Vertical profiler/AUV**	Energy harvesting verticle prfiler
ROV	**Dorado, 0-1000m**	LRAUV deep
ROV	**Benthic Rover with corer**	Benthic Rover with corer
Benthic Rover	**Extended Benthic Rover**	Extended Benthic Rover
wave glider?	**Wave glider**	Wave glider
ship cast/AUV Gulper (in shore)	**Vertical profiler/AUV, Dorado**	Energy harvesting verticle prfiler
wave glider?	**Wave glider**	Wave glider
ship cast/AUV Gulper (in shore)	**Vertical profiler/AUV**	Energy harvesting verticle prfiler
wave glider?	**Wave glider**	Wave glider
ship cast/AUV Gulper (in shore)	**Vertical profiler/AUV**	Energy harvesting verticle prfiler
i2map	**i2map on LRAUVdeep**	i2map on LRAUVdeep
AUV with Holo camera	**AUV with Holo camera**	AUV with Holo camera

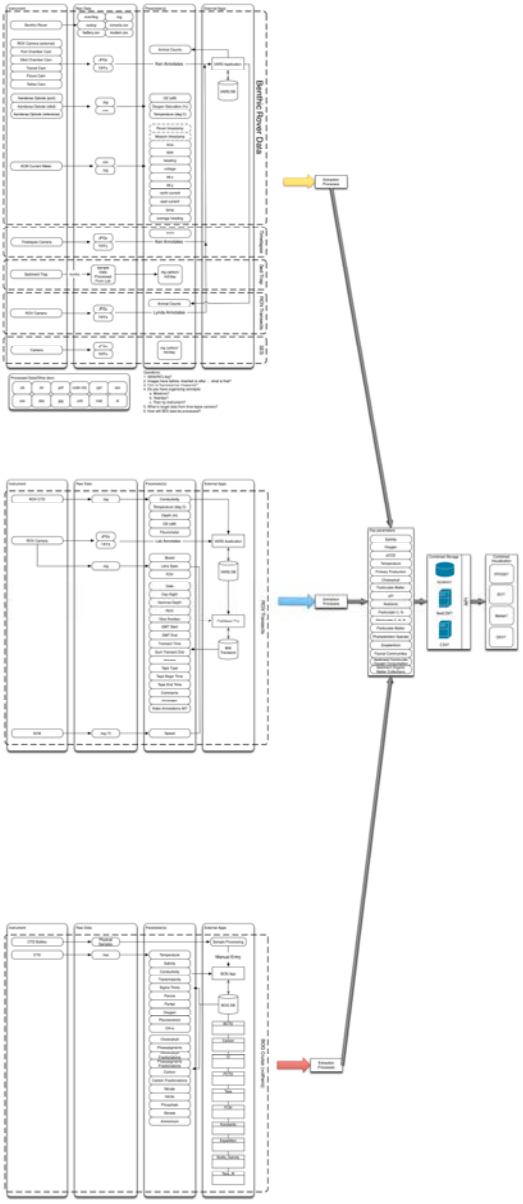
Table 1 ctd.

How often today?	**How often future?**
every 21 days	(blank)
every 21 days	(blank)
every 21 days	(blank)
every 21 days	(blank)
every 21 days	(blank)
3-12 hours	3-12 hours, adjustable
2-4 day	(blank)
every 21 days	(blank)
every 21 days	(blank)
every 21 days	(blank)
daily to weekly	monthly
hourly	(blank)
6-12 months	monthly
every 21 days	(blank)
every 21 days	(blank)

every 21 days	(blank)
every 21 days	(blank)
every 21 days	(blank)
Every two months, Midwater, annually benthic	monthly
every ten days	(blank)
6-12 hour	(blank)
every 21 days	(blank)
every 21 days	(blank)
every ten days	(blank)
every 21 days	(blank)
every 21 days	(blank)
every 21 days	(blank)
Every two months, Midwater, annually benthic	(blank)
6-12 months	(blank)
2-4 day	(blank)
every 21 days	(blank)
every 21 days	(blank)
every 21 days	(blank)
every 21 days	(blank)
every 21 days	(blank)
every 21 days	(blank)
30-60 days	monthly
daily to weekly	(blank)

Appendix, Figure 1. Detailed organization of time-series data integration


Ocean Time-series Studies
o Upper water column
o Midwater
o Pelagic/Benthic
DATA
Collection (Instruments)
Analysis (Processing)
Database (External Apps)
EXTRACTION
Integration
Combined Storage
API Interface
Standard Products
Reports
Statistics
Web pages
Visualization
Applications
Data



Appendix, Figure 2

1. M1: SE 60
2. M2: SE 60
3. M3: SE 60
4. M4: SE 60
5. M5: SE 56

Kevin