

SKrillExI Cruise Report

California Current Ecosystem LTER Program
NH1414, Student Cruise
R/V New Horizon, 26 July – 31 July 2014
Compiled and Submitted by Catherine Nickels
Scripps Institution of Oceanography, Univ. of California, San Diego

Cruise ID: NH1414, aka SKrillExI
Depart: 26 July at 0800 (PDT)
Return: 31 July at 0800
Vessel: R/V New Horizon
Operator: Scripps Institution of Oceanography, Univ. of California, San Diego
Master: Captain Wes Hill
Chief Scientist: Catherine Nickels
Marine Technicians: Brett Hembrough, John Calderwood

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Cruise Science Personnel

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Science Objectives

This cruise explored the ecosystem gradients associated with cross shore bathymetric variation. We tested a set of hypotheses pertaining to the interaction between baleen whales and their krill prey. Analysis of fecal samples suggests that blue whales (*Balaenoptera musculus*) consume certain species of krill (*Thysanoessa spinifera* and *Euphausia pacifica*) more often than other species. Observations of whale positions also suggest that the whales tend to feed in waters above steep bathymetric features. We hypothesized that these specific krill species are associated with, and retained by, the water circulation above the steep bathymetric relief of the continental slope. This hypothesis was tested by conducting a series of cross-shore transects spanning the entire feature at 2 km resolution with continuous active acoustic monitoring at 3 successive locations. Additionally, fecal samples suggest that blue whales preferentially consume larger krill in an aggregation and tag data have shown that blue whales feed at the bottom of acoustically detected krill patches, leading to a second hypothesis that krill are vertically separated by size within patches. This hypothesis was tested using vertically stratified MOCNESS tows through acoustically detected krill patches.

In addition to the whale-krill interaction, our kilometer-scale coverage of the continental shelf break allowed us to determine the distribution of other biotic and abiotic characteristics that may be influencing processes on a fine scale. The cross shelf changes in carbon, nitrogen, and phosphorus ratios, as well as the distribution and activities of phytoplankton and microzooplankton, were determined at each transect station to attain a more complete view of the community structure supporting the krill populations under investigation. Anthropogenic impacts on this nearshore community were assessed through analysis of the distribution of microplastics at each station. Otter trawls on the offshore side of the slope were conducted to characterize the epibenthic megafaunal community in the area.

Overview of Science Plan

The cruise was carried out in the vicinity of Nine Mile Bank (also known as the Coronado Escarpment), a frequent blue whale feeding area. The activities on the cruise were designed to characterize the prey field and surrounding environment. Three transects were completed overnight from near to offshore across the bank feature. Each transect consisted of nine stations (except for transect one in which only six stations were completed) which included a CTD cast on the station and a bongo net towed in the direction of the next station. Bucket samples for microplastic collection were performed at alternating stations. The prey field was characterized vertically by two pairs of day and night MOCNESS tows, performed northward along the bank. The MOCNESS was equipped with a strobe light to mitigate net avoidance by euphausiids, particularly during the daytime tows. Two surveys were also performed with a Moving Vessel Profiler (MVP) to characterize the spatial gradients in the area. The fourth component of the cruise took advantage of the daylight hours by casting deeper into the ocean with an Otter Trawl. Seven otter trawls were conducted to investigate the composition of the benthic community across multiple environmental gradients. Multifrequency active acoustic data were collected continuously throughout the cruise.

Group Reports

Microbiology – Julia Busch

In order to attempt to isolate bacterial strains which produce brominated natural products, water was collected from 18 CTD rosette casts ranging in depth from four to 1192 m. The samples were diluted and plated on marine broth with agar. Invertebrates from four otter trawls and one plankton tow were also collected and the animals were processed, diluted and plated on the previously mentioned media. These samples were also preserved for future culture work and chemical extraction. In total, 143 samples were collected for microbiology work.

Phytoplankton and Microzooplankton– Alexandra Freibott and Alain de Verneil

The phytoplankton group coordinated most CTD operations and completed 27 casts collecting samples at 4 depths in the upper 50 m of the water column. An ISUS nitrate sensor was included on each cast for real-time estimates of nitrate concentration. Each depth was sampled for chlorophyll, nutrients (nitrate, nitrite, phosphate, silicate, ammonium), flow cytometry, epifluorescence microscopy, and acid Lugol's samples. Chlorophyll samples were extracted overnight in acetone before being measured on a Turner fluorometer at sea, while seawater samples for nutrient analysis were frozen and analyzed back on land at the Oceanographic Data Facility (ODF) at Scripps Institution of Oceanography. Flow cytometry samples were frozen in liquid nitrogen and stored until later analysis. Epifluorescence microscopy samples were stained and filtered onto 0.8 and 8 μm black polycarbonate membranes and stored at $-80\text{ }^{\circ}\text{C}$ until later analysis. In addition to the sample collection described above, one replicated, size-fractionated dilution experiment was conducted during the cruise to estimate phytoplankton growth and mortality rates due to microzooplankton grazing. Water for the dilution experiment was collected during the final cast of the second transect at 20 m and incubated for 24 hours in on-deck incubators at 30% light level. Initial and final samples were collected for chlorophyll, flow cytometry, DNA, and epifluorescence microscopy analysis.

Microplastics– Jennifer Brandon

As part of her thesis research, Jenni Brandon collected surface water from metal bucket samples along the three sampling transects. The water was filtered in an all-glass filtering system to prevent contamination. The water was filtered onto glass fiber filters and polycarbonate filters to filter for nanoplastic particles. Then water was also pre-filtered through 202 μm steel mesh to remove larger particulates before being filtered onto the same type of filters. These filters will be run under Raman laser spectroscopy for nanoplastic identification. One pint of water was also removed from each bucket and preserved with formalin for future analysis if needed.

Euphausiids– Catherine Nickels

Bongo tows were performed with a 202µm mesh bongo net for determination of cross-bank gradients in euphausiid distribution. Twenty-six oblique, nighttime tows were performed to approximately 200 m where depth allowed. Both net samples from each tow were preserved in 5% buffered Formalin for later analysis.

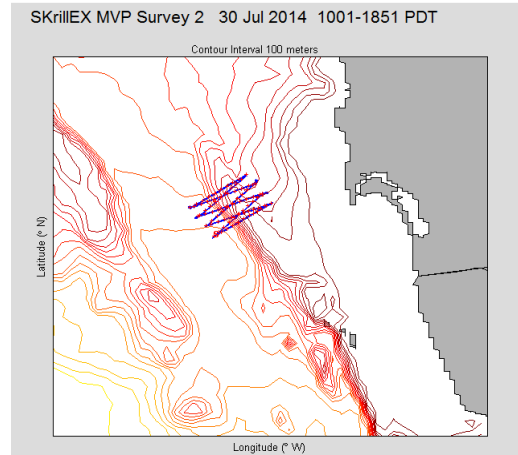
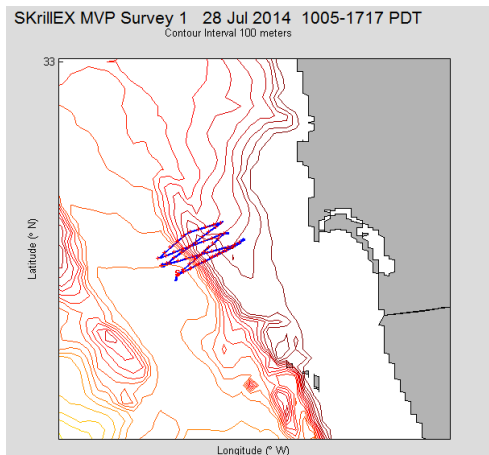
Vertically stratified samples were collected with a MOCNESS for determination of vertical gradients in euphausiid distribution. A strobe-light equipped 1m² MOCNESS with 202 µm mesh was used. Two day and two night tows were completed and all samples were preserved in 5% buffered Formalin for later analysis.

Multifrequency acoustic data (38, 70, 120, and 200 kHz) were collected throughout the cruise with a hull-mounted Simrad EK-60. The data were backed up daily. The data will be used in association with the net tow data for biomass and distribution estimates.

Moving Vessel Profiler (MVP) – Mark Ohman

A free-fall Moving Vessel Profiler was used to characterize spatial gradients across 9 Mile Bank. The properties measured were temperature, salinity, and pressure (AML Micro CTD), Chl-*a* fluorescence (Wetlabs FLRT fluorometer), and suspended particles and size distributions (ODIM Rolls Royce Laser Optical Particle Counter, LOPC). An Acousonde probe (Acoustometrics, model B003A) was also attached to the MVP fish, to record marine mammal vocalizations. Two daytime surveys were completed, including 7 and 8 trans-bank crossings, respectively. Vertical casts extended to a depth of 200 m (bottom depth permitting) at a ship’s speed of 7-8 knots (13-15 km hr⁻¹).

<u>Survey</u>	<u>Date</u>	<u>Time (PDT)</u>	<u>Ship’s speed</u>	<u>No. of casts</u>	<u>Nominal depth</u>
1	28 July 2014	1017-1717	7-8 kts	68	200 m
2	30 July 2014	1001-1851	7-8 kts	84	200 m



Benthic– Natasha Gallo and Kirk Sato

Sampling of the benthic and demersal community was conducted using otter trawls and paired with CTD casts to look at how multiple environmental gradients, including oxygen, temperature, pressure, pH and pCO₂, influence benthic community composition. Replicate quantitative trawl samples were undertaken at ~200 m above or at the upper boundary of the oxygen limiting zone and at ~700 m within the oxygen minimum zone core. Bottle samples from nearby CTD casts were collected and will be analyzed for dissolved inorganic carbon and total alkalinity. Quantitative trawl samples were taken within the oxygen limiting zone at 340 m and the data contributed to a benthic time-series at this site, contributing to our understanding of seasonal and interannual variability of deep-sea benthic communities. A total of 7 trawls were conducted. The data collected will contribute significantly to two PhD student theses and better our understanding of how benthic communities are influenced by multiple environmental gradients on the continental margin. This dataset collected also generates a baseline to compare future ecosystem responses that may follow the strong El Nino.

Daily Activities Schedule

Time	Operation	Latitude	Longitude	Duration	Depth
July 26					
0830	EK60 calibration	At the dock		6.5 hrs	
1300	Transit to first otter trawl				
	MVP test cast	In transit			150m
1630	Otter Trawl 1	32° 42.031' N	117° 23.052' W	2 hrs	360 m
2000	Begin Transect 1	32°42.838' N	117°23.169' W	10 hrs	
2100	Transect 1: Station 1, Bucket and CTD on coordinates, bongo to next station 1 st station CTD to bottom	32°42.838' N	117°23.169' W	1 hr	Bongo: 200m CTD: 300m Bucket: Surface
2230	Transect 1: Station 2	32°42.277' N	117°24.232' W	1 hr	Bongo: 200m CTD: 100m Bucket: Surface
2330	Transect 1: Station 3	32°41.124'N	117°26.530'W	1 hr	Bongo: 200m CTD: 100m Bucket: Surface
July 27					
0100	Transect 1: Station 4	32°39.985'N	117°28.725'W	1 hr	Bongo: 200m CTD: 100m Bucket: Surface
0230	Transect 1: Station 5	32°38.622'N	117°31.236'W	1 hr	Bongo: 200m CTD: 100m Bucket: Surface
0330	Transect 1: Station 6	32°38.104'N	117°32.250'W	1 hr	Bongo: 200m CTD: 100m Bucket: Surface
	Finish last bongo	32°37.555'N	117°33.281'W	1 hr	
0600	Transit to otter trawl site	32° 40.320'N	117° 21.251'W	1.5 hrs	
0700	Otter trawl 2	32° 40.320'N	117° 21.251'W	2 hrs	200 m
1000	CTD	32° 43.867'N	117° 21.589'W	1.5 hrs	200 m
1200	Otter trawl 3	32° 43.867'N	117° 21.589'W	2 hrs	200 m
1500	Otter Trawl 4	32° 49.265'N	117° 22.159'W	2 hrs	200 m
1830	Survey 700m stations	32°53.446'N	117°28.468'W	1 hr	
2100	Bongo tow 1	32°39.244'N	117°28.067'W	1 hr	200 m
2200	Finish bongo tow	32°38.478'N	117°29.417'W		
2330	MOCNESS 1	32°37.529'N	117°27.695'W	3 hrs	200 m

July 28					
	End MOCNESS 1	32°41.078'N	117°30.573'W		
0630	MOCNESS 2	32°37.529'N	117°27.695'W	3 hrs	200 m
	End MOCNESS 2	32°41.078'N	117°30.573'W		
1000	MVP 1	32°36.225'N	117°30.162'W	8.5 hrs	200 m
		7 kts			
	MVP 1: start	32°36.225'N	117°30.162'W	1 hr	200 m
	MVP 1: Waypoint 1	32°39.699'N	117°23.371'W	1 hr	200 m
	MVP 1: Waypoint 2	32°37.423'N	117°31.422'W	1 hr	200 m
	MVP 1: Waypoint 3	32°42.153'N	117°25.106'W	1 hr	200 m
	MVP 1: Waypoint 4	32°39.467'N	117°33.857'W	1 hr	200 m
	MVP 1: Waypoint 5	32°43.831'N	117°25.802'W	1 hr	200 m
	MVP 1: Waypoint 6	32°38.104'N	117°32.250'W	1 hr	200 m
	MVP 1: Waypoint 7	32°40.903'N	117°24.892'W	1 hr	200 m
	End	32°36.225'N	117°30.162'W		
2000	Begin Transect 2	32°41.989'N	117°22.771'W	10 hrs	
2000	Transect 2: Station 1, Bucket and CTD on coordinates, bongo to next station	32°41.989'N	117°22.771'W	1 hr	Bongo: 200m CTD: 300m
2100	Transect 2: Station 2	32°41.448'N	117°23.793'W	1 hr	Bongo: 200m CTD: 100m Bucket: Surface
2200	Transect 2: Station 3	32°40.903'N	117°24.892'W	1 hr	Bongo: 200m CTD: 100m
2300	Transect 2: Station 4	32°40.354'N	117°25.935'W	1 hr	Bongo: 200m CTD: 100m Bucket: Surface
July 29					
0000	Transect 2: Station 5	32°39.812'N	117°26.987'W	1 hr	Bongo: 200m CTD: 100m
0100	Transect 2: Station 6	32°39.244'N	117°28.067'W	1 hr	Bongo: 200m CTD: 100m Bucket: Surface
0200	Transect 2: Station 7	32°38.478'N	117°29.417'W	1 hr	Bongo: 200m CTD: 100m
0300	Transect 2: Station 8	32°37.932'N	117°30.454'W	1 hr	Bongo: 200m CTD: 100m Bucket: Surface
0400	Transect 2: Station 9	32°37.423'N	117°31.422'W	1 hr	Bongo: 200m CTD: 100m
0500	Finish last bongo	32°36.865'N	117°32.367'W	1 hr	
0600	Transit to otter trawl site	32° 51.320'N	117° 29.712'W	2 hrs	

0800	Otter trawl 5	32°53.446'N	117°28.468'W	3 hrs	700 m
1100	CTD	32° 52.370'N	117° 28.991'W	2 hrs	700 m
1300	Otter trawl 6	32° 52.370'N	117° 28.991'W	3 hrs	700 m
1600	Otter trawl 7	32° 48.770'N	117° 28.054'W	3 hrs	700 m
2000	Begin Transect 3	32°40.965'N	117°22.272'W	10 hrs	
2000	Transect 3: Station 1, Bucket and CTD on coordinates, bongo to next station	32°40.965'N	117°22.272'W	1 hr	Bongo: 200 m CTD: 300 m Bucket: Surface
2100	Transect 3: Station 2	32°40.427'N	117°23.291'W	1 hr	Bongo: 200m CTD: 100m Bucket: Surface
2200	Transect 3: Station 3	32°39.962'N	117°24.303'W	1 hr	Bongo: 200m CTD: 100m Bucket: Surface
2300	Transect 3: Station 4	32°39.490'N	117°25.283'W	1 hr	Bongo: 200m CTD: 100m Bucket: Surface
July 30					
0000	Transect 3: Station 5	32°38.871'N	117°26.292'W	1 hr	Bongo: 200m CTD: 100m Bucket: Surface
0100	Transect 3: Station 6	32°38.349'N	117°27.308'W	1 hr	Bongo: 200m CTD: 100m Bucket: Surface
0200	Transect 3: Station 7	32°37.706'N	117°28.656'W	1 hr	Bongo: 200m CTD: 100m Bucket: Surface
0300	Transect 3: Station 8	32°37.227'N	117°29.625'W	1 hr	Bongo: 200m CTD: 100m Bucket: Surface
0400	Transect 3: Station 9	32°36.711'N	117°30.501'W	1 hr	Bongo: 200m CTD: 100m Bucket: Surface
0500	Finish last bongo	32°36.163'N	117°31.399'W	1 hr	
0800	MVP 2	32°36.225'N	117°30.162'W	8.5 hrs	
		7 kts			
	MVP 2: start	32°36.225'N	117°30.162'W	1 hr	200 m
	MVP 2: Waypoint 1	32°39.699'N	117°23.371'W	1 hr	200 m
	MVP 2: Waypoint 2	32°37.423'N	117°31.422'W	1 hr	200 m
	MVP 2: Waypoint 3	32°42.153'N	117°25.106'W	1 hr	200 m
	MVP 2: Waypoint 4	32°39.467'N	117°33.857'W	1 hr	200 m
	MVP 2: Waypoint 5	32°43.813'N	117°25.802'W	1 hr	200 m
	MVP 2: Waypoint 6	32°38.104'N	117°32.250'W	1 hr	200 m

	MVP 2: Waypoint 7	32°40.903'N	117°24.892'W	1 hr	200 m
	MVP2: end	32°36.225'N	117°30.162'W		200 m
2100	Bongo tow 2	32°39.244'N	117°28.067'W	1 hr	200 m
	Finish bongo tow	32°38.478'N	117°29.417'W		
2333	MOCNESS 3	32°37.529'N	117°27.695'W	3 hrs	200 m
July 31					
	End MOCNESS 3	32°41.078'N	117°30.573'W		
0630	MOCNESS 4	32°37.529'N	117°27.695'W	3 hrs	200 m
	End MOCNESS 4	32°41.078'N	117°30.573'W		
0930	Head back to port				
	Offload				

Map of Sampling Locations

