STAR 2006: NOAA Ship *David Starr Jordan*
Weekly Science Report

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Science Summary: 5 - 11 October 2006

This is a "Core Area" leg. The Jordan will be spending its 20 days of Leg 4 surveying that geographic region where spotted and spinner dolphins are most abundant. As is the case for almost everything out here, the Core Area is big – stretching from the coast of the Americas to 120 degrees west longitude, and from 5 degrees north to a latitude equivalent to half way up the peninsula of Baja California, Mexico. We will visually scan, passively listen to, photograph and dip our nets, XBTs, and CTDs into four northeast by southwest-running swaths of ocean that range from 800 to 1500 km long and touch the coast in three places. When one is outside the Core Area, it is sometimes viewed as a relatively homogeneous body of water but once inside, the variations become obvious.

This week, although we were not expecting it, we touched the northwest corner of the Costa Rica Dome, a distinct hydrographic feature created by the Equatorial Countercurrent, running the width of the entire Pacific Ocean from west to east, and right on into the Central American continent, with a good part of the water being deflected to the north and back out to sea again. The result is a counter-clockwise gyre which causes the water in the center to diverge and deeper waters to come to the surface. This "upwelling-modified" water is high in surface chlorophyll and the favored habitat of common dolphins and blue whales. In fact, (and even while our oceanographer was excitedly carrying on in the back lab about chlorophyll levels and thermal profiles), we biologists first noticed evidence of the Dome this week by the appearance of these animals (one blue whale pooped right in front of the ship, another showed up at our evening station), and the distinctively green (i.e. not the clear, turquoise-blue of travel office poster fame) color of the water that is its trademark. Although the nominal location of the dome is 9N, 90W, it is not a static feature, but moves around depending upon hydrographic and meteorological conditions – as we clearly saw this week.

There followed our transit into the Gulf of Tehuantepec, a legendary locale for the horrendous winds that can often be found there (fortunately for us though, all was quiet) and then, our 1500 km run offshore. It was on this long transit where we finally began to see true blue water, high abundance of spotted and spinner dolphins with bird flocks and associated tuna, and three encounters that I will not soon forget. One - An angry-looking rain squall bearing down on us is accompanied by black clouds that are billowing upwards in Wizard of Oz-like fury. From the handheld radios throughout the ship comes Gary's voice "Hey – if you're within range of my voice, you'd best come outside and see". Sure enough, a waterspout is winding its way down from the clouds above our heads in a thin but clearly defined gray-colored column that sways and pulses as if a living thing. As it further develops, the energy locked in the upper reaches of the column touch the sea (not very far!) in front of us, causing the water in the small circle of ocean surface touched by the spout to be whipped right up into the air in a frenzied twister of white water vapor. As scientists, officers, and crew watch, frankly, somewhat mesmerized by the power of nature, the entire column passes off our starboard side and on into the distance, our trance suddenly broken by the pounding rain that follows with drenching finality (end of show!). Two – An hour after sunset we can see a lighted area on the water surface in the distance ahead of the ship - just the sort of scene a bright moon breaking through heavy clouds on a dark night would make. But the light is not coming from the moon, but from beneath the surface. It is made by a half-mile radius-sized patch of invertebrates lighting up the ocean. As we steam through it, fist-sized objects of all shapes sparkle like brilliant white lights, perturbed by the motion of the water, and (I am not making this up) a dolphin jets in to ride the bow, leaving a trail of sparkling water stars streaming from its tail and looking for all the world like a scene right out of Fantasia. The patch continues to glow alone in the distant sea of blackness as we leave it behind. Three – killer whales! The small boat is already in the water preparing to sample from a spotted and spinner dolphin with bird flock assemblage when they are sighted and we quickly change plans. In comes the boat to drop off Nacho, pick up Ernesto and crossbows, Cornelia for photos, and Carl for posterity. We are trying to relocate the whales during the personnel swap when suddenly, they show up … right behind the

boat! There follows a dramatic view from my vantage point on the flying bridge wing; Chico holding the small boat alongside the *Jordan* while people climb out of and then in, focusing on their own actions, while three, then four killer whales, each as long as the launch itself, swim alongside it and just below the surface, distinctly visible in that now, near transparent water. They (the killer whales) are clearly curious and not in the least intimidated ("we are in control"), those in the launch are frantically trying to gather equipment in time for sampling, we on the flying bridge can't seem to stop yelling at everyone in general and no one in particular that "the killer whales are *right there*!" in the spectacular excitement of the encounter.

Sightings and Effort Summary for Marine Mammals

Date	Start/ Stop Time	Position	Total nmi	Average Beaufort
100506	0704	N10:05.19 W092:38.46	49.3	4.8
	1849	N09:08.99 W092:58.53		
100606	0807	N08:15.23 W093:40.52	41.9	4.6
	1823	N08:42.71 W094:28.17		
100706	0709	N09:51.91 W094:20.99	52.4	1.7
	1548	N11:01.60 W094:15.42		
100806	0706	N12:40.07 W094:08.17	78.4	3.5
	1848	N14:12.36 W094:04.02		
100906	0712	N15:35.87 W093:54.82	61.6	4.4
	1850	N14:32.12 W094:48.12		
101006	0718	N13:30.19 W095:44.49	76.5	3.3
	1851	N12:11.79 W096:49.10		
101106	0754	N11:11.60 W097:37.88	42.4	2.3
	1802	N10:22.13 W098:25.07		

Code	Species	Number of Sightings
001	*Mesoplodon peruvianus*	2
002	*Stenella attenuata* (offshore)	8
003	*Stenella longirostris* (unid. Subsp.)	1
006	*Stenella attenuata graffmani*	2
010	*Stenella longirostris orientalis*	6
013	*Stenella coeruleoalba*	6
015	*Steno bredanensis*	5
017	*Delphinus delphis*	7
018	*Tursiops truncatus*	15
021	*Grampus griseus*	2
036	*Globicephala macrorhynchus*	1
037	*Orcinus orca*	1
048	*Kogia sima*	2
049	Ziphiid whale	1
072	*Balaenoptera edeni*	2
075	*Balaenoptera musculus*	3
077	Unid. dolphin	2
Total		66

Photography (Cornelia Oedekoven, Laura Morse, Adam Ü)

Ok, we photographed twelve schools of various dolphin species this week. We photographed one sighting of pilot whales, one Bryde's whale and three blue whales. But I don't think anybody wants to hear about those when we have much more exciting news to share involving killer whales! With their ability to hide

combined with their general intolerance of boats, ETP killer whales can be one of the most frustrating species to photograph out here. Usually we get one or two chances before they either leave us in the dust or just vanish without a trace, but on October 11 we were blessed with a group of whales that showed genuine curiosity towards the DSJ and the small boat. Numerous individuals came over to check out the small boat as it pulled alongside for a personnel transfer, which allowed the paparazzi stationed on the flying bridge to shoot away and collect amazing full-frame shots. In many cases the whales were too close to photograph, especially for those photographers that chose long lenses thinking they'd be shooting at distant specks. Even after the whales made their close pass they stayed tight and easy to track, and even more spectacular images were collected from both the DSJ and the small boat. When it was all said and done we had collected over 300 images of the animals. Analyzing this many images can take a lot of patience but thanks to the overall high quality of the images it went rather smoothly. After we went through our images (photographs confirmed nine animals in total) we compared them to the new SWFSC ETP killer whale catalog, compiled by Paula Olson, which contains individual ID's of killer whales from previous cruises. It was during this process when we discovered that five of our nine whales matched photographs of animals taken in 1999!

This is the sort of discovery that gets photo-ID people excited, because it gives us a window into the lives of ETP killer whales. By comparing our images to the catalog we can see that this group appears to be a stable family unit that appears to travel together over long periods of time, as it is unlikely that we would have encountered the same five whales together seven years apart if they were unrelated. We can also add a few new juveniles to the family, which gives us an idea on their recruitment, and by comparing sighting locations, we get a hint towards understanding the movement patterns and potential home ranges of this group. The photographs also allow us to look at changes in the individuals over time, such as the acquisition and healing of nicks and scratches.

Species Code	Species	This week	Total
002	*Stenella attenuata* (offshore)	4	14
003	*Stenella longirostris* (unid.)		6
006	*Stenella attenuata graffmani*		11
010	*Stenella longirostris orientalis*	3	7
002/010	*St. l. orientalis/a* (offshore)		2
013	*Stenella coeruleoalba*		11
015	*Steno bredanensis*	3	11
017	*Delphinus delphis*		30
018	*Tursiops truncatus*	2	34
021	*Grampus griseus*		7
032	*Feresa attenuata*		1
036	*Globicephala macrorhynchus*	1	12
037	*Orcinus orca*	9*	13*
046	*Physeter macrocephalus*		20*
049	*Ziphiid whale*		1
063	*Berardius bairdii*		3
072	*Balaenoptera edeni*	1	3
074	*Balaenoptera physalus*		2*
075	*Balaenoptera musculus*	3*	21*
076	*Megaptera novaeangliae*		6*
090	*Stenella attenuata* (unid.)		1
099	*Balaenoptera borealis/edeni*		6

* Individual whales photographed

Biopsy (Juan Carlos Salinas Vargas and Ernesto Isaac Vázquez Morquecho)

Species	Common Name	# Weekly samples	# Weekly Takes	Total Samples	Total Takes
Balaenoptera edeni	Byrde's whale	1	1	4	4
Balaenoptera musculus	Blue whale	0	0	9	17
Delphinus delphis	Short-beaked common dolphin	0	0	19	40
Globicephala macrorhynchus	Short-finned pilot whale	1	2	62	137
Megaptera novaeangliae	Humpback whale	0	0	2	5
Orcinus orca	Killer whale	6	10	7	17
Physeter macrocephalus	Sperm whale	0	0	8	8
Stenella attenuata	Pantropical spotted dolphin	9	15	21	38
Stenella attenuata graffmani	Coastal spotted dolphin	0	0	27	42
Stenella coeruleoalba	Striped dolphin	0	0	2	8
Stenella longirostris orientalis	Eastern spinner dolphin	2	12	8	32
Stenella longirostris subsp.	unidentified spinner dolphin	0	0	25	42
Steno bredanensis	Rough-toothed dolphin	4	4	11	22
Tursiops truncatus	Bottlenose dolphin	3	3	48	78
		26	47	253	490

Seabirds and Marine Debris (Rich Pagen and Chris Cutler)

The world as seen through the eyes of a wayward migrant songbird which accidentally finds itself (due to wind, weather, or a faulty internal compass) hundreds of miles from shore must appear as strange and ominous as the one Bilbo Baggins came across in Tolkien's The Hobbit. Take, for example, an American Redstart like one of the three that came to rest and feed (well, attempt to feed) on our mobile steel island this week. Despite our excitement when one of these lost travelers pays us a visit, the whole experience of being in an unfamiliar "land" with few options for food or rest must be terrifying, confusing and very physically taxing. Though the redstart didn't come across any elves or dragons on its travels (although getting picked up by Engineer Sam Velez after having wandered deep down into the engine room may have seemed a lot like getting snatched up by a dragon after getting lost deep in its lair), it certainly saw countless creatures its eyes had never seen before.

If the Redstart covered much of the same ground that we did this week, then its experience would have been a lot like the following. The most noticeable theme in the realm of seabirds this week was their patchiness. Occasional encounters with seabird flocks (often associated with dolphins and tuna) broke up the long stretches of nearly bird-free ocean. Nazca and Red-footed Boobies, Wedge-tailed and Pink-footed Shearwaters, and a sprinkling of Arctic Terns made up the core of the flocks, while Tahiti Petrels and Leach's and Galapagos Storm-petrels patrolled the empty spaces. Sabine's Gulls, Red Phalaropes and Pomarine and Parasitic Jaegers were also seen in small numbers this week, all of them Arctic breeders which have flown to these waters to pass the winter months.

The redstart may have caught glimpses of some other birds that it probably assumed were, like the boobies and storm-petrels, natives of this landless territory. But, like the redstart, quite a few other landbirds found themselves in a similar unfortunate predicament: Yellow-breasted Chat, Northern Parula, Prothonotary, Yellow Warbler, Black-throated Green Warbler, Tropical Kingbird, Baltimore Oriole, Great Blue Heron, and a Cattle Egret that participated in turtle processing on the back deck (OK, he was actually more interested in the occasional fish or goose-neck barnacle he was offered by the humans working up the turtles).

Marine debris was also patchy this week, with one area offshore of the Gulf of Tehuantepec being surprisingly thick with human-made debris. Perhaps the redstart also noticed this patch of flotsam, mulling over the thought of whether landing on a 55-gallon drum or a fishing float would be a good idea,

or rather a certain ticket to the big pool. Whatever its decision, it did decide to stay with us for awhile, and has since moved on, we can only hope in the direction of land.

Turtle Operations (Lindsey Peavey, *et al.*)

On 07 October we captured an adult male, 62.1 cm straight carapace length (SCL), with a circle hook embedded in its lower mandible, right side. No doubt from longline fishing gear, it was clear the fishermen had seen they had a turtle hooked instead of the desired large, predatory fish and cut the monofilament, most likely before even lugging the turtle onboard, leaving almost nine feet of it for the turtle to tow from its new, unwanted jaw jewelry. Although disturbing and sad, the turtle had gotten hooked in a place that allowed it to survive and function, to an extent. The area where the hook was rubbing against the lower jaw was scarred, and the tissue surrounding the hook's entry point was necrotic, suggesting it was not a recent injury and the turtle had probably been living with it for a while, and seemed to be doing OK. He was one of the lucky turtles. Of the thousands that get incidentally caught on fishing gear in the ETP, most do not fare as well. After emailing out some photos of this guy's case, I had colleagues that wrote back with their own unfortunate stories and photos of turtles that weren't so lucky. By understanding where sea turtles spend most of their time, both distributionally and at what depths in the water column, management teams can work with fishers on how to avoid sea turtle 'hot spots' altogether. There are adjustments that can be made to save turtle lives, and prevent unnecessary injury like the one our endangered reptilian friend was suffering from. He was released free of the hook and line, and is expected to heal just fine.

Not to be overshadowed was the exciting event of attaching another SDR (Satellite-Linked Time-Depth Recorder) to the carapace of a healthy, adult female (62.8 SCL). Named after our beloved Mexican sperm whale and squid biologist who sailed with us on Legs 1 and 2 of this STAR cruise, "Iliana" was captured in a high *L. olivacea* (common name: olive ridley) density area in the Gulf of Tehuantepec, along the Middle America Trench reaching depths of over 5500 meters. While Ph.D. student Iliana Ruiz-Cooley was sailing with us, she fell in love with sea turtles, as many people do, and was a constant figure on the back deck when turtles were being processed. She was my much-appreciated right-hand woman for a little over a month, and is a good friend. We all miss her smile and energy on the DSJ. We processed 31 olive ridleys this week, despite the last two days being painfully slow turtle-wise as we steam offshore just south of the Tehuantepec Ridge and away from the hot spot.

Species	**Common name**	**Number sampled**	
		Weekly	**Total**
Caretta caretta	Loggerhead	0	8
Eretmochelys imbricata	Hawksbill	0	1
Lepidochelys olivacea	Olive ridley	31	172
Total		31	181

Fish Sampled for Diet and Isotope Analysis

Species	Samples	
	Weekly	Total
Yellowfin tuna	1	22
Skipjack*	2	13
Wahoo		3
Mahi mahi		11

*includes black skipjack

Oceanographic Operations (Candy Hall)

During June to November the Costa Rica Dome is thought to swell (excuse the pun!) zonally

from 300 to 1000kms (Fiedler, 2002), especially westward along the North Equatorial Countercurrent thermocline ridge (~10 ºN). In a northerly direction, the Dome maintains a shallow thermocline as it reaches toward the Gulf of Tehuantepec (Fiedler, 2002). In the Gulf of Tehuantepec, site of an infamous wind jet region, chlorophyll is reported to be prolific during October (Fiedler, 2002), and this was quite apparent in our sampling. Since leaving Guatemala, our oceanographic instruments have collected pertinent information regarding the delineations of the most important localized feature in this region of the Pacific Ocean, the Costa Rica Dome.

As our CTD numbers move into the 3-digit range (celebrated with a Centennial CTD Caper of "Guess which Niskin bottle crosses onto the deck first"), we are firmly in Eastern Tropical Pacific waters. Our thermoclines are intense and relatively shallow, changing rapidly over a short depth, varying only marginally in their 20 ºC isotherm depth indicator. High sea surface temperatures (28.6 – 30.6 ºC; 83 – 87 ºF), a shallow surface mixed layer, a temperature-synchronized halocline [above which the salinity decreases (32 – 33.5 psu) in agreement with the signature surface layer of low-salinity Tropical Surface Water], are all represented within our CTD and XBT profiles. Ballance *et al*. (2006) summarized previous research: "an assemblage of spotted and spinner dolphins [are] found in greatest frequency in waters underlain by a sharp thermocline, generally >2 ºC $10m^{-1}$, at depths usually much less than 50m, with surface temperatures above 25 ºC and surface salinities below 34 pss". Those are exactly the exhilarating physical water properties we are witnessing.

Over most of the Pacific Ocean, evaporation rates vary much less than precipitation rates (P-E). Nowhere is this more apparent than in the Intertropical Convergence Zone, clearly denoted as a ridge of high P-E values, wherein the Trade winds converge in an often-spectacular manner. Twice we have witnessed Beaufort 0/1 seas turn foul on us in less than 5 minutes, as waterfalls of penetrating rain and rough sea squalls made a mockery of our aft deck and small boat operations. To conclude with the oceanographic *coup de grace* of this cruise; a waterspout, so well defined and graceful, swept across our bow and past our starboard side, finally elicited coveted words of wonder from all for the awesome majesty that is Our Ocean.

Date	CTD	XBT	Bongo tow	Manta tow
5 Oct	2	3	1	1
6 Oct	2	3	1	1
7 Oct	2	3	1	1
8 Oct	2	3	1	1
9 Oct	2	3	1	1
10 Oct	2	3	1	1
11 Oct	2	3	1	1
Total	14	21	7	7

Fiedler, P.C. 2002. The annual cycle and biological effects of the Costa Rica Dome. Deep-Sea Research I 49: 321 – 338.

Ballance, L.T., Pitman, R.L. and Fiedler, P.C. 2006. Oceanographic influences on seabirds and cetaceans of the eastern tropical Pacific: A review. Progress in Oceanography 69: 360 – 390.