



# Diagnostic Monitoring of Rip Currents on Southern California Beaches

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**NOAA National Weather Service  
Office of Science and Technology  
Meteorological Development Laboratory**

Thanks to:

Jason Taylor, Mike Churma, and Andrew MacArthur (MDL)

David Soroka and Wayne Presnell (OCWWS)

Noel Isla and Ivory Snow (SGX)

David Danielson (LOX)



# Rip Current Forecasts

- NWS forecasts the risk of rip currents in the Nation's coastal waters, including the Great Lakes
- 3 tiered approach of risk - low, moderate, high
- Routine forecasts included in the Surf Zone Forecast
- If a moderate or high risk is forecast, some offices include in the Coastal Hazards Message and Hazardous Weather Outlook products for broader distribution



# Rip Current Education/Outreach

- Rip Currents cause over 100 fatalities per year in the U.S.
- Account for 80% of the rescues by lifeguards
- NWS and NOAA's Sea Grant program have placed warning signs in English and Spanish at many locations



**RIP CURRENTS**  
**Break the Grip of the Rip!**

ESCAPE ESCAPE  
ESCAPE ESCAPE  
RIP CURRENT

Rip currents are powerful currents of water moving away from shore. They can sweep even the strongest swimmer out to sea.



**IF CAUGHT IN A RIP CURRENT**

- ◆ Don't fight the current
- ◆ Swim out of the current, then to shore
- ◆ If you can't escape, float or tread water
- ◆ If you need help, call or wave for assistance

**SAFETY**

- ◆ Know how to swim
- ◆ Never swim alone
- ◆ If in doubt, don't go out

More information about rip currents can be found at the following web sites:  
[www.ripcurrents.noaa.gov](http://www.ripcurrents.noaa.gov)  
[www.oceo.org](http://www.oceo.org)



# Rip Current Awareness Week

- Break the Grip of the Rip Awareness week is first full week in June each year
- Nationwide dissemination of rip current safety and awareness info
- NWS partners with National Sea Grant, National Park Service, and the U.S. Lifesaving Association



**San Diego Tribune**

**High surf coming to Southern California**

July 23, 2009

LOS ANGELES — Southern California is in for some big surf beginning tonight, **according to the National Weather Service.**

Northward-advancing swells are expected to produce a rise in surf along south-facing shores, with the swell peaking tomorrow and continuing through the weekend. Some sets could be up to 7 feet, forecasters said. That's good news for the Hurley U.S. Open of Surfing in Huntington Beach, but forecasters said the potential for rip currents is high.







# Big surf, rip currents keep lifeguards busy

By Mike Freeman

San Diego Tribune Staff Writer

July 26, 2009

San Diego lifeguards made about four times more rescues than usual for a summer Saturday yesterday as high surf and rip currents continued to bash local beaches.

City lifeguards performed 268 rescues, compared with 50 to 80 for a normal weekend summer day, lifeguard Lt. Nick Lerma said.

Yesterday's blitz came on top of about 300 rescues by city lifeguards Friday, Lerma said.

A storm thousands of miles offshore has brought unusually large waves and powerful currents to Southern California beaches during the past few days.

"It's somewhat unusual for us to get these surf conditions in the summertime," Lerma said. "This one hit us pretty hard."

One of the more serious rescues involved swimmers yesterday afternoon near Sunset Cliffs in Ocean Beach.

**"We had a mass-rescue incident involving about 10 people in a rip current,"** Lerma said.

Lifeguards used a boat and several personal watercraft and were assisted by two surfers in the area, Lerma said. No one was seriously injured.

Elsewhere, several beachgoers suffered minor injuries from being pounded by the strong shore break.

Waves reached as high as 10 feet in parts of La Jolla and other south-facing beaches, Lerma said. In general, waves ranged from 3 feet to 8 feet, **the National Weather Service said.**





# Mega Rip at Huntington State Beach July 25, 2009





## Moonlight Beach July 22-27 2009 Swell Case Study

Date	Surf Height (ft)	Tide	Surf Zone Width	Rip Strength
07/22/09 AM	2	Low	150	Weak
07/23/09 PM	4	Mid	300	Moderate
07/24/09 AM	8	Mid	450	Moderate
07/25/09 AM	7	Low	390	Strong
07/26/09 AM	3	Mid	150	Weak
07/26/09 PM	5	High	300	Moderate
07/27/09 AM	3	Low	120	Weak
07/27/09 PM	2	High	150	Moderate



# Newport Beach Data for July 24-26, 2009



<b>Date</b>	<b>Rescues</b>	<b>Daily Beach Population (6 miles)</b>	<b>Preventative Actions</b>
<b>7/24/09</b>	381	85,000	6,835
<b>7/25/09</b>	261	90,000	6,639
<b>7/26/09</b>	255	100,000	4,739
<b>Totals</b>	897	275,000	18,213



# The Capacity of the Rose Bowl is 91,136 people



Swimmers warned to stay out of Lake Michigan because of rip currents,  
turbulent water

*The Grand Rapids Press August 03, 2009*





# Background

- Key Recommendation of a 2004 NWS Rip Current Technical Workshop:
  - “ A pilot program should be implemented to monitor and study rip currents so as to reduce the hazard they pose to the public”





## Fundamental Principle



Observations drive NWS science which in turn drives NWS products and services.

Without observations of rip currents we can not hope to provide improved rip current forecasts for beach safety.

So how do we get these observations?  
Lifeguards? Trained Spotters?



# Our Goal

*To obtain rip current and surf wave data for various beaches in Southern California for the purpose of developing and validating tools to improve the National Weather Service's rip current forecasts and related products*





## Questions We Sought to Answer



- Is the quality of the manual lifeguard observations of sufficient for scientific analysis?
- Can we train a novice to be a rip current spotter?
- Are the CDIP buoy/model derived observations able to approximate the human surf zone observations?
- Do we have any skill in diagnosing the conditions which give rise to dangerous rip currents?
- Is the Moonlight Beach pilot project feasible for other lifeguarded beaches?







# Surf Zone and Rip Current Monitoring Locations





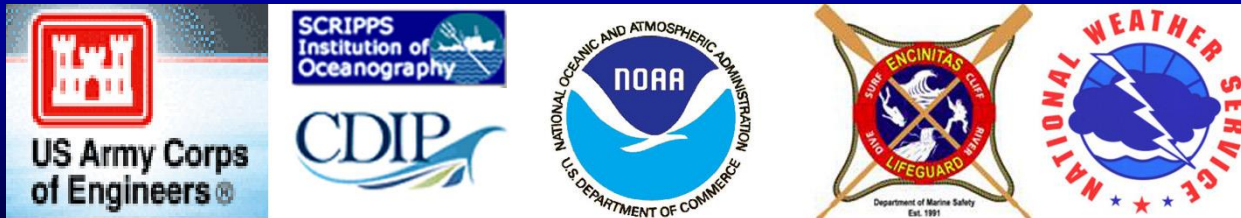
# Lifeguard-Provided Rip Current Observations

## Moonlight Beach



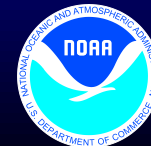
# A Strong Partnership

1. Meteorological Development Laboratory, National Weather Service
2. San Diego Weather Forecast Office, National Weather Service
3. City of Encinitas, Office of Marine Safety, Beach Lifeguard
4. Coastal Data Information Program (CDIP) of the SCRIPPS Institution of Oceanography of UCSD
5. US Army Corps of Engineers, Los Angeles District





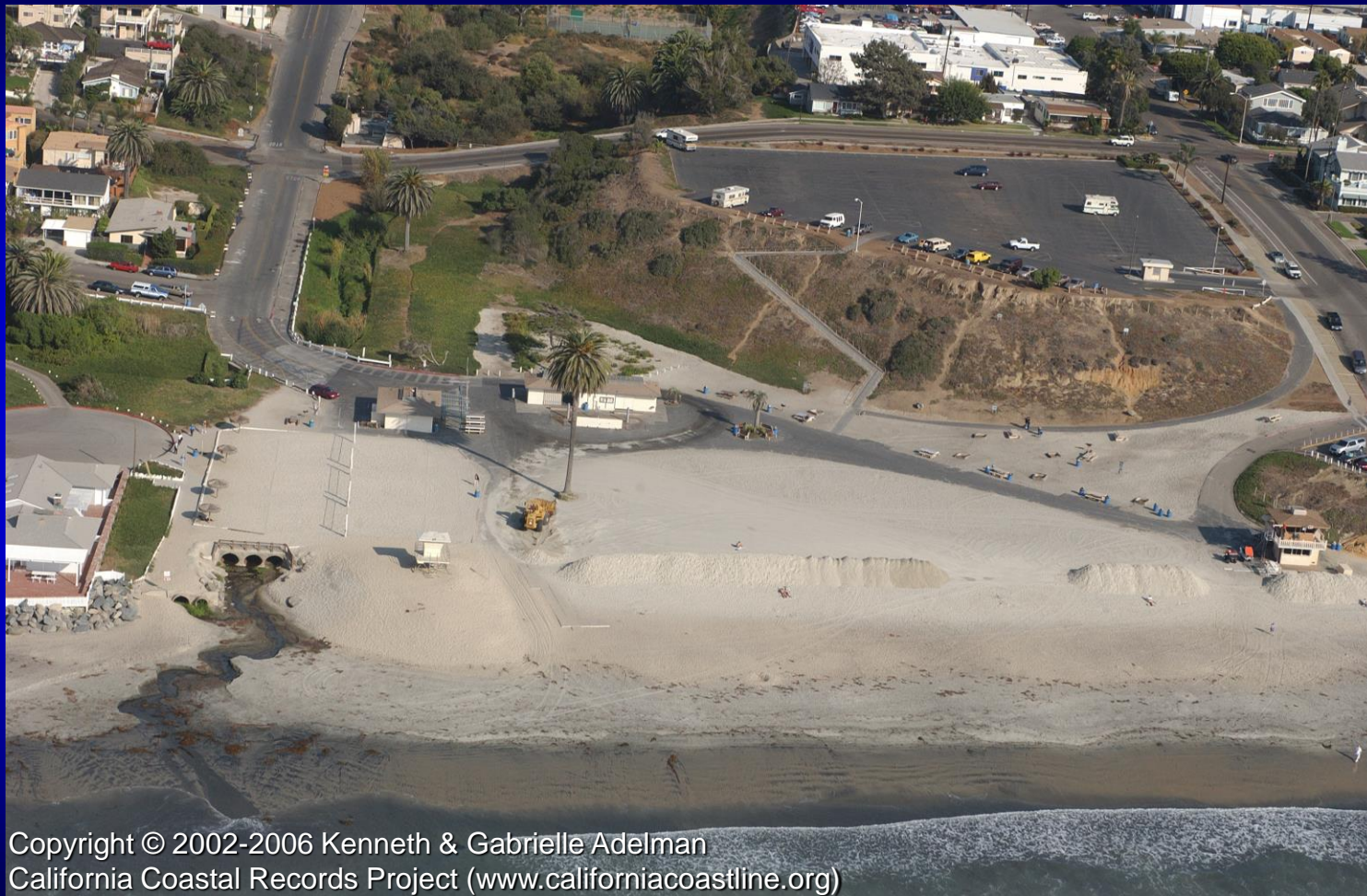
(Listed from left to right):  
Julie Thomas, Andrew MacAuthor, Dr. William O'Reilly, Dr. C-S Wu, Michael Khuat, Ivory Small, Mayor Maggie Houlihan, Noel Isla, Dr. Stephan Smith, Capt. Larry Giles, Jason Taylor, and Sgt. David Rains







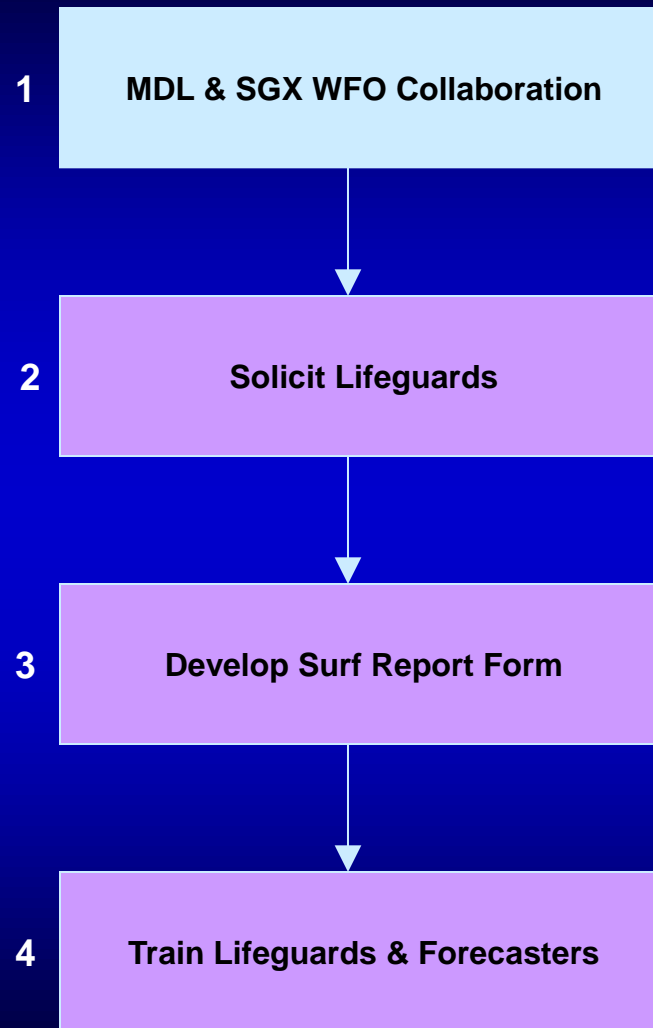
# Aerial Photo of Moonlight Beach Observation Area



Copyright © 2002-2006 Kenneth & Gabrielle Adelman  
California Coastal Records Project ([www.californiacoastline.org](http://www.californiacoastline.org))



# Moonlight Beach Surf Zone Monitoring Project Setup



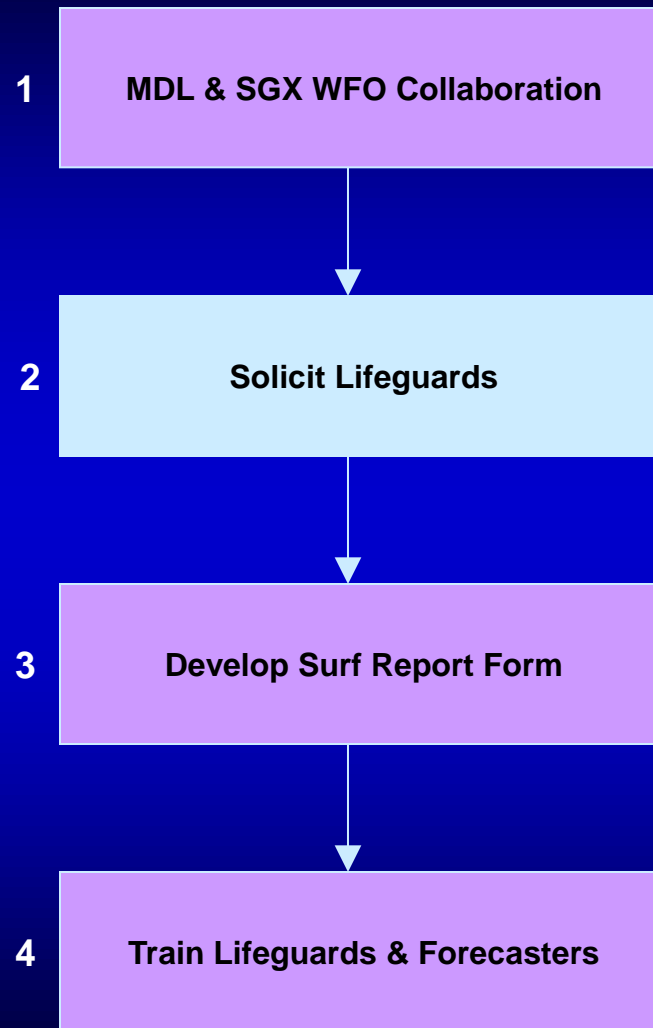
## Collaboration with local WFOs



Ivory Small (SOO), Dr. C-S Wu, and Noel Isla (HT) at San Diego Weather Forecast Office.



# Moonlight Beach Surf Zone Monitoring Project Setup

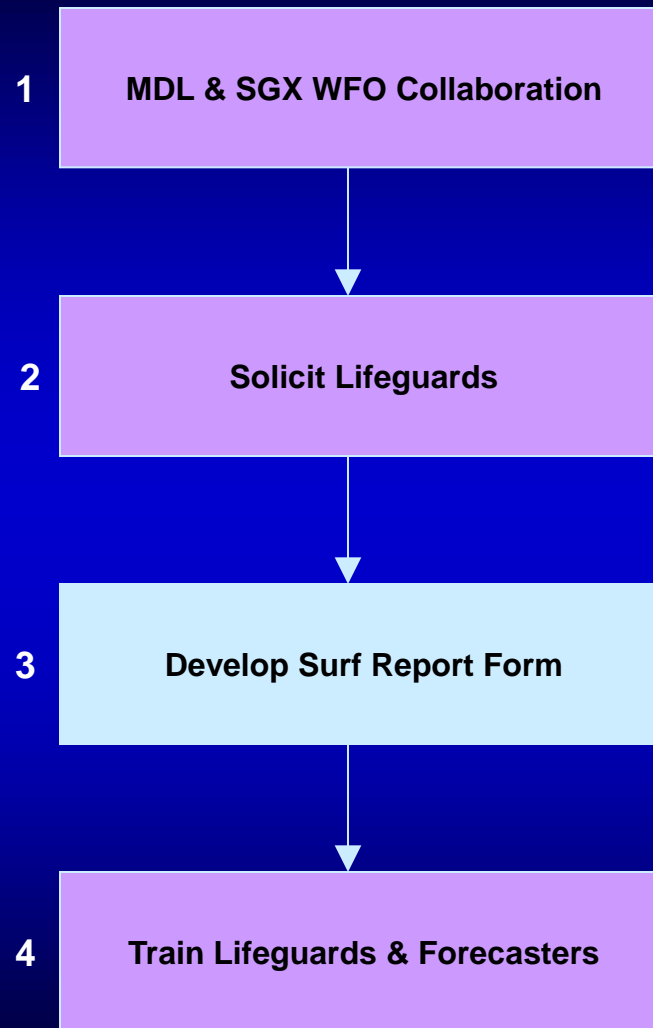




**Scott Davey (Section Chief- LA Lifeguard Division)  
discusses the NOAA/LA Lifeguard partnership at the  
Lifeguard Training Center.  
(From left to right) Michael Bateman (LA Lifeguard), Dave  
Danielson (SOO), CS Wu, and Mike Churma.**



# Moonlight Beach Surf Zone Monitoring Project Setup



# Surf Zone Monitoring Report Form

## Surf Zone Rip Monitoring Report

FAX TO: (858)-675-8712

Beach ID: **Moonlight Beach**

Date: \_\_\_/\_\_\_/\_\_\_

Observations range from B-street to D-street

mm dd yyyy

10:00AM: \_\_\_\_\_

4:00 PM: \_\_\_\_\_

### Waves :

Maximum Surf height (ft) = \_\_\_\_\_; Wave Period (sec.) = \_\_\_\_\_

Average Surf Zone Width (ft) = \_\_\_\_\_;

Tides: Low Rising High Falling

Incoming wave direction: \_\_\_\_\_ Directly on- shore \_\_\_\_\_ Oblique to the shore

**Rip Currents:** Is there a rip: \_\_\_ YES \_\_\_ NO.

Estimated Time of Rip Occurrence: \_\_\_\_\_

Rip Strength: \_\_\_ Weak, \_\_\_ Moderate, \_\_\_ Strong

Number of Rips: \_\_\_ Single, \_\_\_ Multiple (2-4), \_\_\_ Wide stack (5+)

Rip location relative to Street names: **E---+---D---+---C---+---B---+---A** Street  
Tower

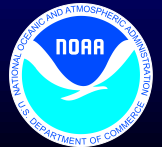
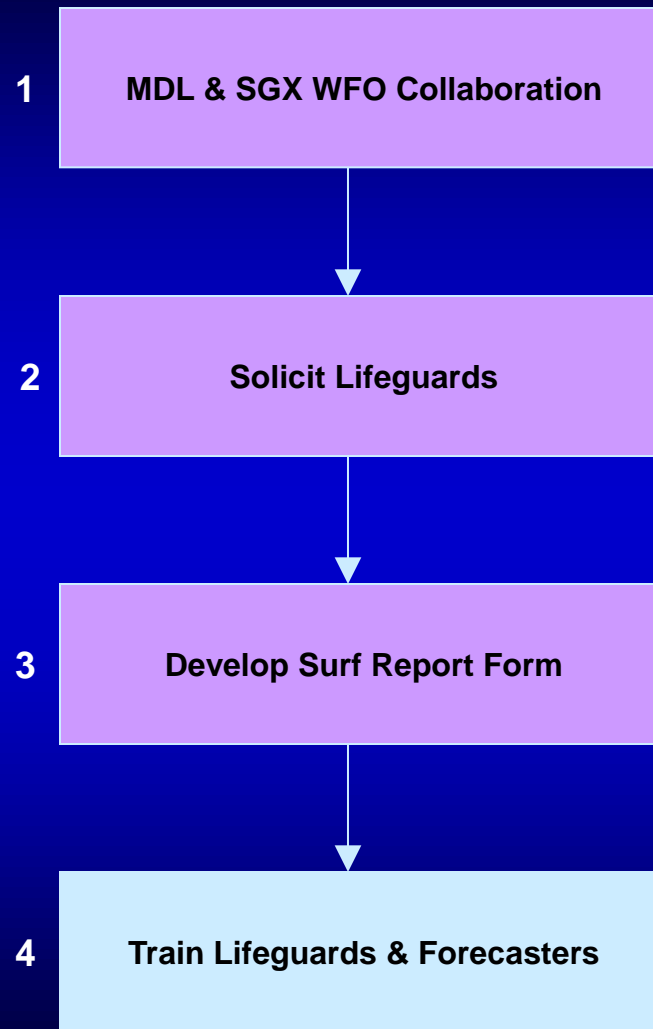
**Comments:** ( # of rescues, bars, rip life, beach face, cusps, wave sequences):

\_\_\_\_\_

Prepared by Lifeguard: \_\_\_\_\_



# Moonlight Beach Surf Zone Monitoring Project Setup



# Jason Taylor, Dr. C-S Wu, and Noel Isla at Moonlight Beach Lifeguard Tower



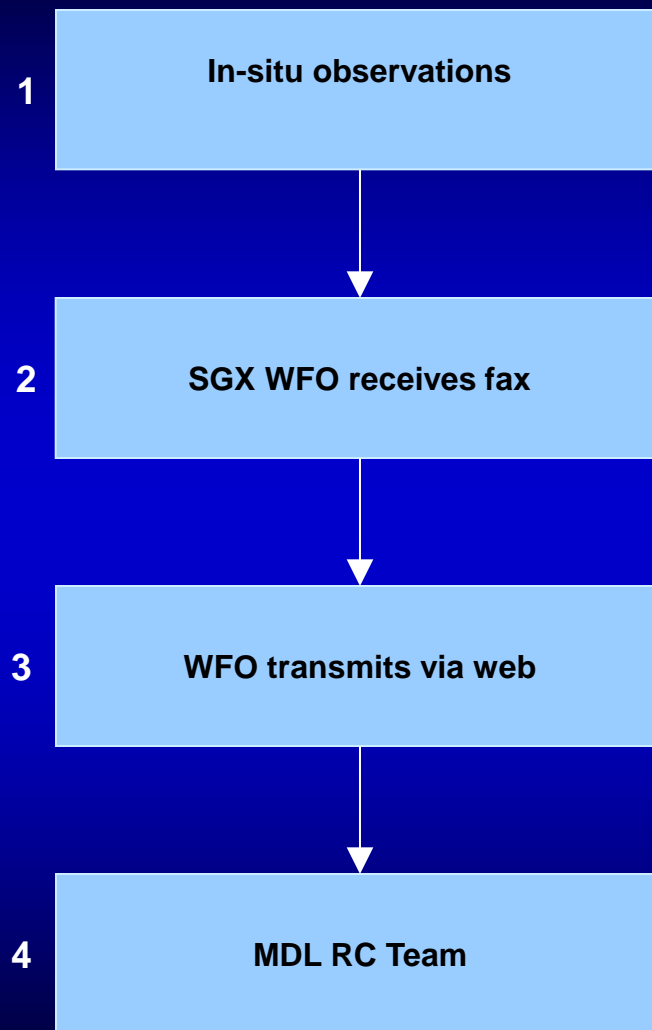


## Southern California Rip Current Research Project Beach Observation Coverage Periods

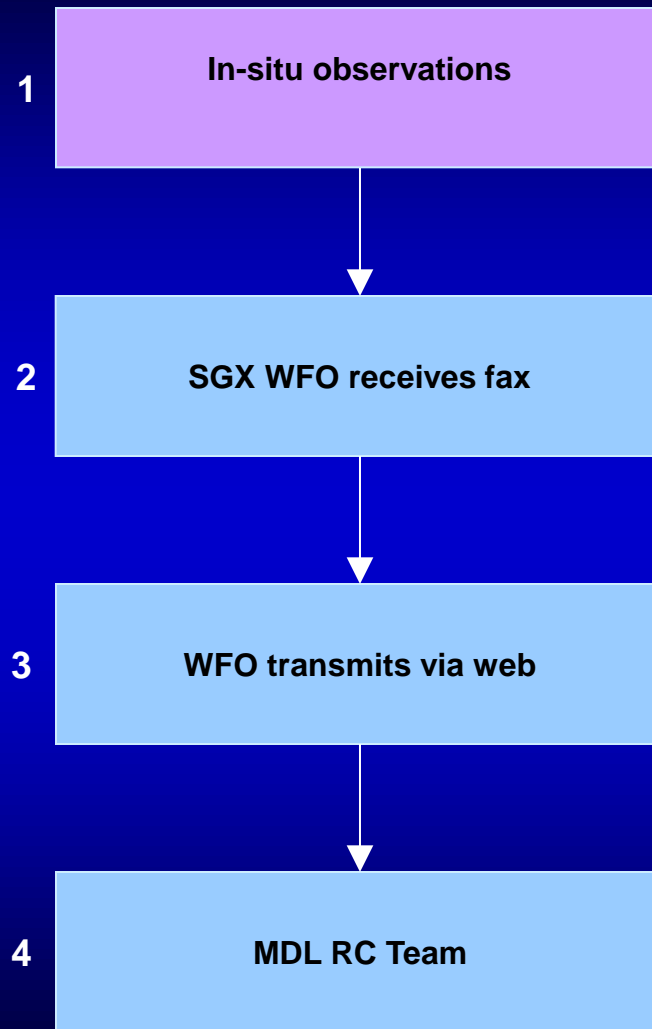
Beach Period	Moonlight Beach Open ( an open beach)	Manhattan Beach (a beach inside a bay)	Zuma Beach (a beach half protected)	Coming soon: Mission And Newport Beaches
<b>2007</b>	<b>4/12 to 12/31/07</b>	<b>None</b>	<b>None</b>	
<b>2008</b>	<b>4/1 to 12/30/08</b>	<b>9/1 to 11/12/08</b>	<b>None</b>	
<b>2009</b>	<b>1/3 to Present</b>	<b>4/1 to 5/15/09</b>	<b>4/1 to 6/30</b>	



# Moonlight Beach Surf Zone Monitoring Project Process

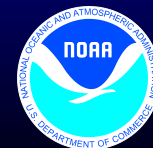


# Moonlight Beach Surf Zone Monitoring Project Process

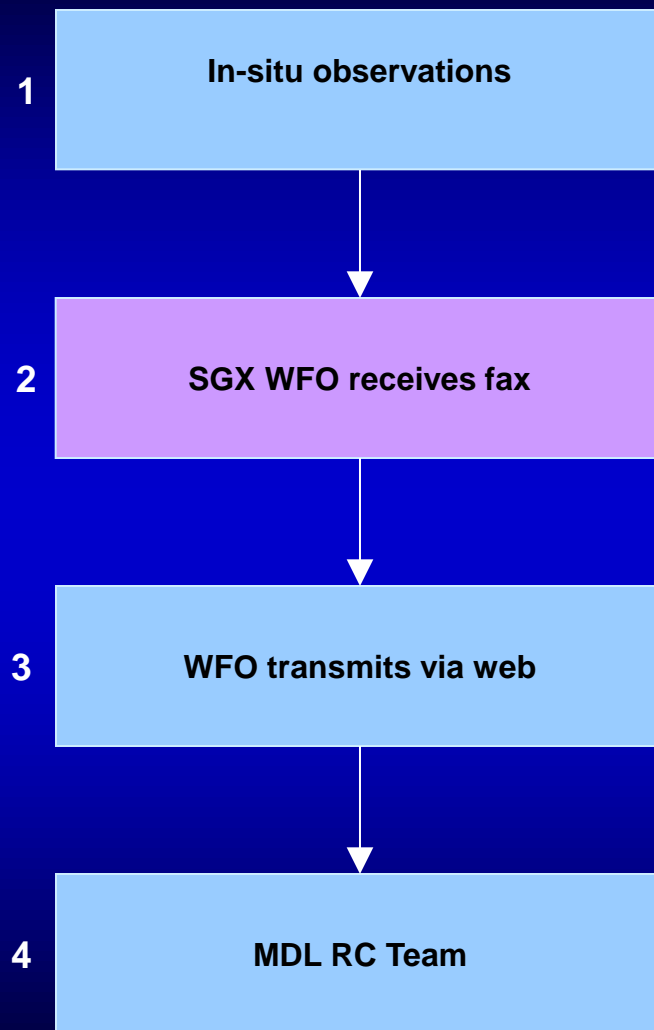




# Moonlight Beach Google Earth Map



# Moonlight Beach Surf Zone Monitoring Project Process





# Surf Zone Monitoring Report Form

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mm dd yyyy

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Estimated Time of Rip Occurrence: \_\_\_\_\_

Rip Strength: \_\_\_ Weak, \_\_\_ Moderate, \_\_\_ Strong

Number of Rips: \_\_\_ Single, \_\_\_ Multiple (2-4), \_\_\_ Wide stack (5+)

Rip location relative to Street names: **E---+---D---+---C---+---B---+---A** Street  
Tower

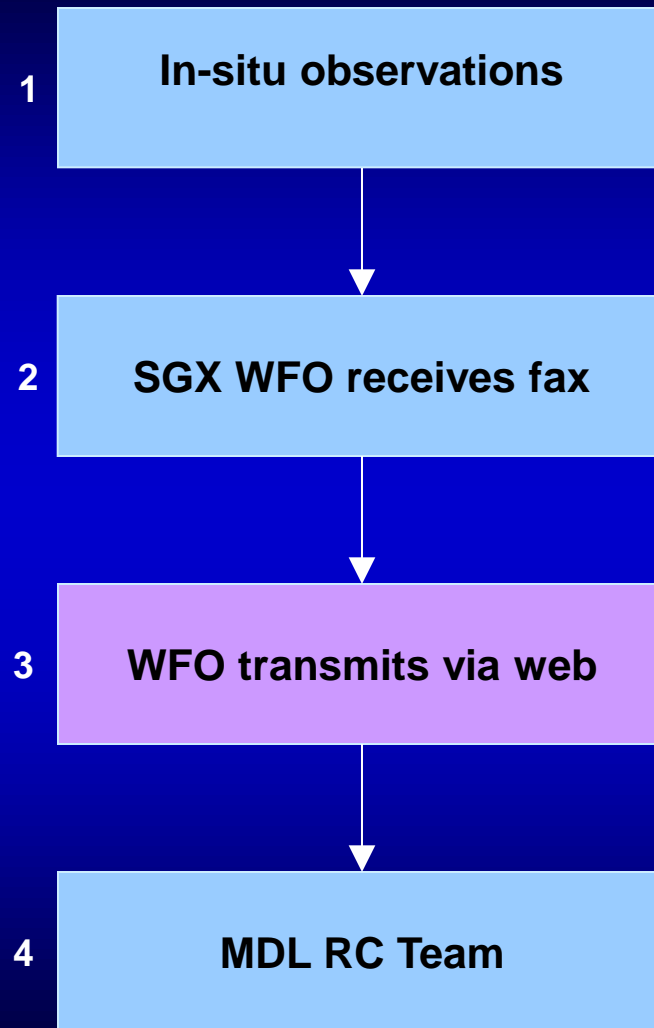
**Comments:** ( # of rescues, bars, rip life, beach face, cusps, wave sequences):

\_\_\_\_\_

Prepared by Lifeguard: \_\_\_\_\_



# Moonlight Beach Surf Zone Monitoring Project Process



# Surf Zone Monitoring Report Web Form



## The Surf Zone Rip Monitoring Report



<b>Beach ID :</b> Not on List <input type="text"/>	<b>Date (mm/dd/yyyy) :</b> 08/7/2009 <input type="text"/>	<b>Report Time :</b> <input type="text"/>
---	--	--

### Waves:

<b>Surf height (ft) :</b> <input type="text"/>	<b>Period (sec.) :</b> <input type="text"/>	<b>Surf Zone Width (ft) :</b> <input type="text"/>	<b>Tide :</b> Select Tide <input type="text"/>
<b>Incoming wave direction:</b> Select Direction <input type="text"/>			

### Rip Hazrds

<b>Rip Observed :</b> Yes <input type="text"/>	<b>Rip Currents :</b> Select Rip Strength <input type="text"/>	<b>Number of Rips :</b> Select Rip Strength <input type="text"/>
<b>Estimated Time of RIP :</b> <input type="text"/>	<b>RIP Location :</b> <input type="text"/>	

### Surf Forecast (SRFSGX)

<input type="text"/>
----------------------

### Additional Information:

<b>Comments:</b> <input type="text"/>	<b>Lifeguard:</b> <input type="text"/>
--	--

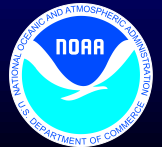
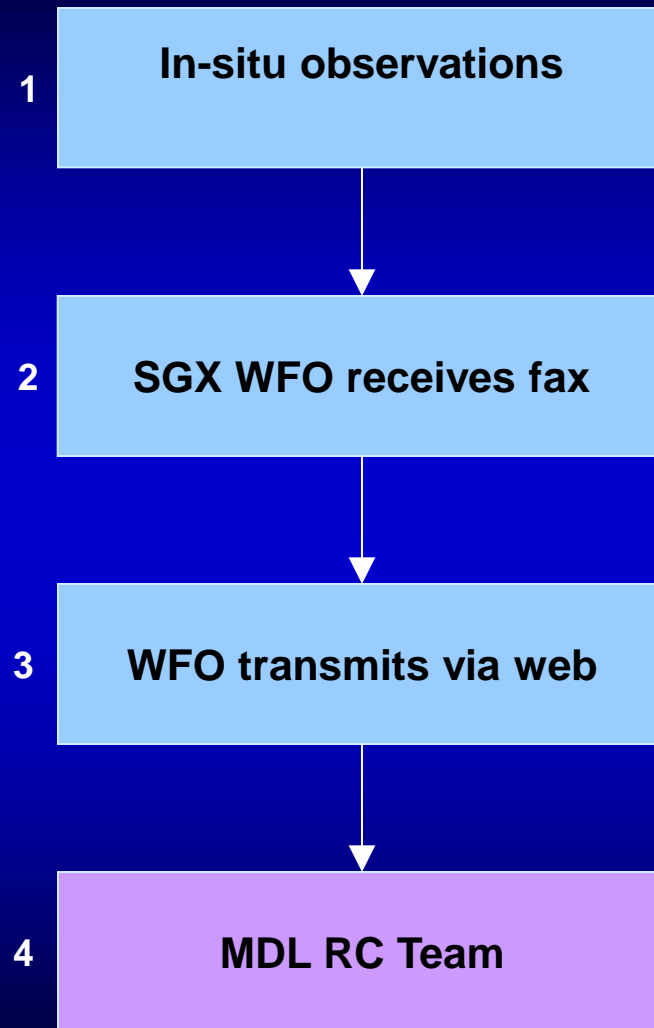
Submit your report

Reset

Exit



# Moonlight Beach Surf Zone Monitoring Project Process



# Example Surf Zone Monitoring Report Electronic Output

## Surf Zone Rip Monitoring Report:

Beach ID: Moonlight Beach

Date: 03/23/2009

Time: 10:50

### Waves:

Surf height (ft): 5

Period (sec.): 8

Surf Zone Width (ft): 300

Tide: Mid

Incoming wave direction: Directly on-shore

Rip Observed: Yes

Rip Currents: Strong

Number of Rips: Multiple

Estimated Time of RIP: continuous

RIP Location: E++++ ++A

### Additional Information:

Lifeguard: H.A.

Forecaster: Stan Wasowski

Comments:

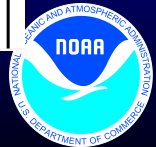




# Example Data Table of Surf Zone Report for Spring 2008

Moonlight Beach Surf Zone Rip Monitoring Report in Spring and Summer 2008

Date AM/PM	Surf Height (ft)		Wave Obs.	CDIP	Surf Zone (ft)	Tide	Incoming Wave	Rip	Strength	# of Rips	Comments
	Obs.	CDIP									
04/12 AM	1.5	1.8	10	14.3	225	Low	Dir.	Y	Moderate	Multiple	Along shore trench 75 ft wide is feeding a flow of water into rips. Sandbars shallow. (2 rescues)
04/12 PM	2.5	1.8	12	13.3	150	High	Obl.	Y	Moderate	Multiple	Two long shore currents joined to form a consistent rip in front of station. High tide and swell dir. change.
04/13 AM	2	1.7	8	13.3	225	Low	Dir.	Y	Moderate	Single	(4 rescues)
04/13 PM	2	1.7	8	14.3	150	High	Dir.	Y	Weak	Multiple	(29 rescues)
04/14 AM	2	1.6	10	13.3	150	Mid	Dir.	Y	Moderate	Multiple	Rip lasted approx. 5 minutes.
04/15 AM	4	5.0	10	9.1	450	Mid	Dir.	Y	Weak	Multiple	Moderate NW sideshore current.
04/17 AM	3	3.1	9	18.2	N/A	Mid	Dir.	Y	Weak	Multiple	Longshore hole and current feeding gap in sand bar.
04/18 AM	3	3.1	12	15.4	270	High	Dir.	Y	Weak	Multiple	N/A
04/18 PM	3	3.6	12	18.2	270	Low	Dir.	Y	Moderate	Multiple	N/A
04/22 AM	3	3.4	10	7.7	75	Mid	Dir.	Y	Weak	Single	N/A
04/22 PM	2	2.9	8	7.7	75	Mid	Dir.	Y	Weak	Multiple	No estimated time of rips was reported.
04/29 AM	4	4.2	12	11.1	150	Low	Dir.	Y	Weak	Multiple	N/A
04/30 AM	4	5.5	11	9.9	750	High	Dir.	Y	Moderate	Multiple	Strong lateral rip flowing from B St. past C St.
05/01 AM	5	4.4	12	10.5	180	Mid	Dir.	Y	Moderate	Multiple	N/A
05/02 AM	6	3.9	12	16.7	525	Mid	Obl.	Y	Strong	Multiple	Sets of 5 to 7 waves with lulls lasting 5 to 6 minutes allowing for significant pulling rips.
05/03 AM	5	3.7	12	15.4	450	Mid	Obl.	Y	Moderate	Multiple	Rips lasted 3 to 4 minutes.
05/04 PM	3	3.0	10	15.4	450	Mid	Obl.	Y	Weak	Multiple	N/A
05/08 AM	2	3.3	10	7.1	300	Low	Dir.	Y	Weak	Multiple	Persistent longshore trench & current feed rip.
05/08 PM	2	3.1	10	7.7	225	Low	Dir.	Y	Weak	Multiple	N/A
05/10 AM	3	2.6	8	9.9	300	Low	Dir.	Y	Weak	Multiple	N/A
05/11 AM	2	2.2	14	13.3	90	Low	Obl.	Y	Weak	Single	Small rips off of cottonwood stream. Large exposed sandbar spanning length of the beach.
05/13 AM	3	3.7	8	10.5	120	Mid	Dir.	Y	Moderate	Multiple	Longshore deep hole/trench. Large sandbar just inside of outer most wave zone.
05/13 PM	3	3.9	7	10.5	90	High	Dir.	Y	Weak	Single	High tide inshore hole. Not many people on beach.
05/16 AM	1	2.0	9	9.9	120	Mid	Dir.	Y	Moderate	Multiple	N/A
05/18 PM	4	2.9	12	14.3	450	Low	Dir.	Y	Strong	Multiple	12 rescues
05/19 AM	4	3.2	14	12.5	180	High	Dir.	Y	Strong	Multiple	5 rips.
05/20 AM	3	3.1	7	13.3	210	Mid	Obl.	Y	Moderate	Multiple	Big inshore hole rip pulls off direction of swell. So swell is NW, rip pulls back North inside.
05/20 PM	3	3.0	7	13.3	300	High	Dir.	Y	Moderate	Multiple	Big inshore holes even on high tide.
05/23 PM	3	5.0	9	11.1	450	High	Dir.	Y	Moderate	Single	Poor weather conditions. Few visitors.
05/24 AM	2	3.1	9	10.5	375	Mid	Dir.	Y	Moderate	Multiple	Windy, rainy. Few visitors.
05/28 PM	2	2.2	9	13.3	90	Mid	Dir.	Y	Moderate	Multiple	N/A
05/29 PM	2	2.3	8	5.9	60	Low	Dir.	Y	Moderate	Multiple	N/A
05/30 PM	2	2.9	8	6.7	60	Low	Dir.	Y	Moderate	Multiple	Small surf but rips still present.
05/31 PM	2	2.8	8	6.7	300	High	Dir.	Y	Weak	Multiple	N/A
06/01 AM	3	3.1	8	7.1	300	Low	Dir.	Y	Weak	Multiple	N/A
06/02 AM	2	3.4	10	8.3	300	Low	Dir.	Y	Weak	Multiple	N/A
06/02 PM	2	2.9	10	9.1	300	High	Dir.	Y	Weak	Multiple	N/A
06/04 AM	4	3.7	10	8.3	300	Low	Dir.	Y	Moderate	Multiple	N/A
06/04 PM	4	3.9	10	8.3	300	Mid	Dir.	Y	Moderate	Multiple	N/A



# Buoy - Station 46225, 100 Torrey Pines Outer, CA

**Waverider Buoy**  
**32.930 N 117.393 W**  
**(32°55'49" N 117°23'33" W)**



## Buoy - Station 46225, 100 Torrey Pines Outer, CA

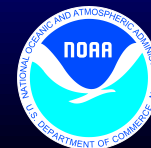
- Current status:  
**operational**
- Most recent location:  
**32 55.84 N 117 23.54 W**  
**(32.9307 - 117.3924)**
- Instrument description:  
**Datawell directional buoy**
- Most recent water depth (MLLW):  
**555 m (1821 ft, 304 fm)**
- Measured parameters:  
**wave energy, wave direction, sea temperature**
- NDBC/WMO identifier:  
**46225**

- **Photo Gallery**
- **Photo log:**  
**invertebrate growth**



**100 - Station Map**

Approximately 6.5 nm W of Torrey Pines State Beach





# Moonlight Beach CDIP MOP (D0722) Transect Parameter Map

Transect Parameter Map: D0722 Viewing Ta

Select parameter: Hs Tp Dp Ta Sxx Sxy Dm Vm Hb

Transects will be overlaid below.



Time (UTC):

2009-08-18

16:00:00

Parameters:

Hs : 0.60 m

Tp : 15.38 s

Dp : 247 deg

Ta : 6.81 s

Sxx : 0.0212 m<sup>2</sup>

Sxy : 0.0003 m<sup>2</sup>

Dm : 254.00 deg

Vm : 0.05 m/s,

upcoast

Hb : 0.75 m

[View static map](#)

[Next transect](#)

[Prev transect](#)

[Move upcoast](#)

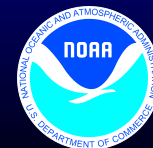
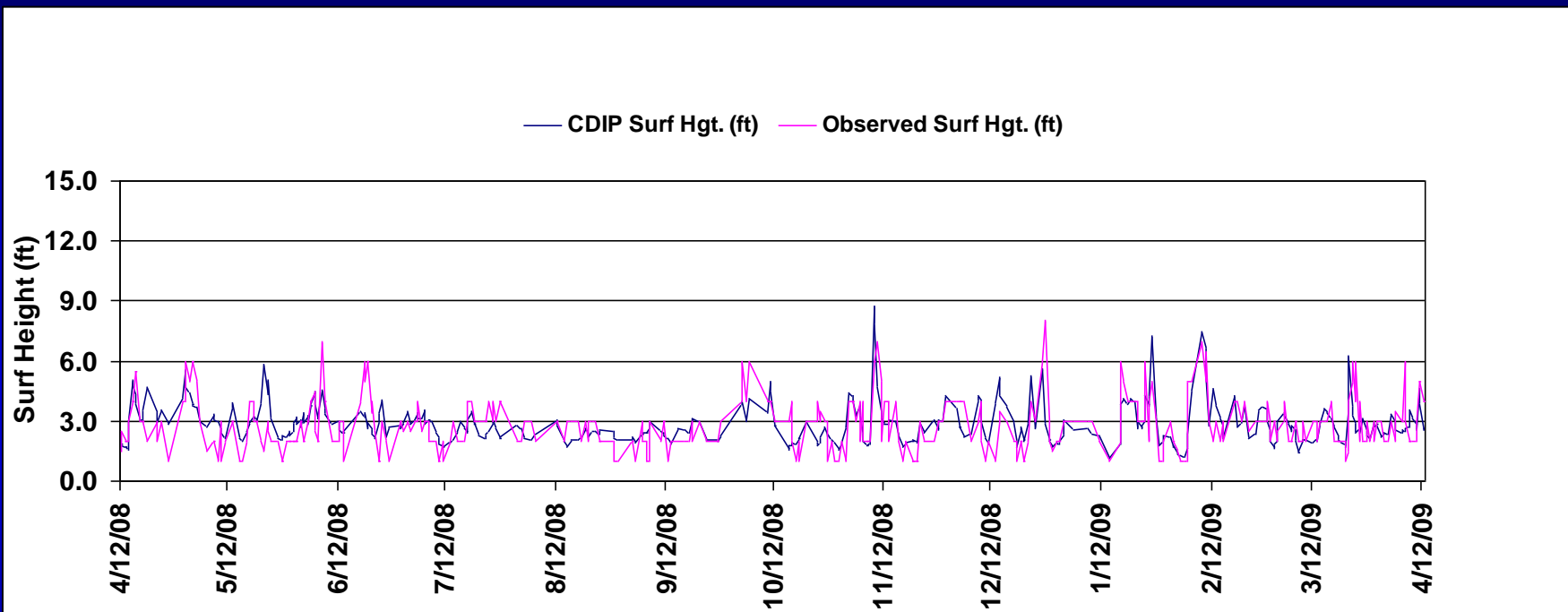
[Move downcoast](#)



POWERED BY Google  
 Imagery ©2009 DigitalGlobe, GeoEye, U.S. Geological Survey, Map data ©2009 Tele Atlas, Terms of Use



# Moonlight Beach Observed vs. CDIP Surf Height (4/12/2008-4/12/2009)





## Manual Observations vs. CDIP Buoy/Model-Derived Data

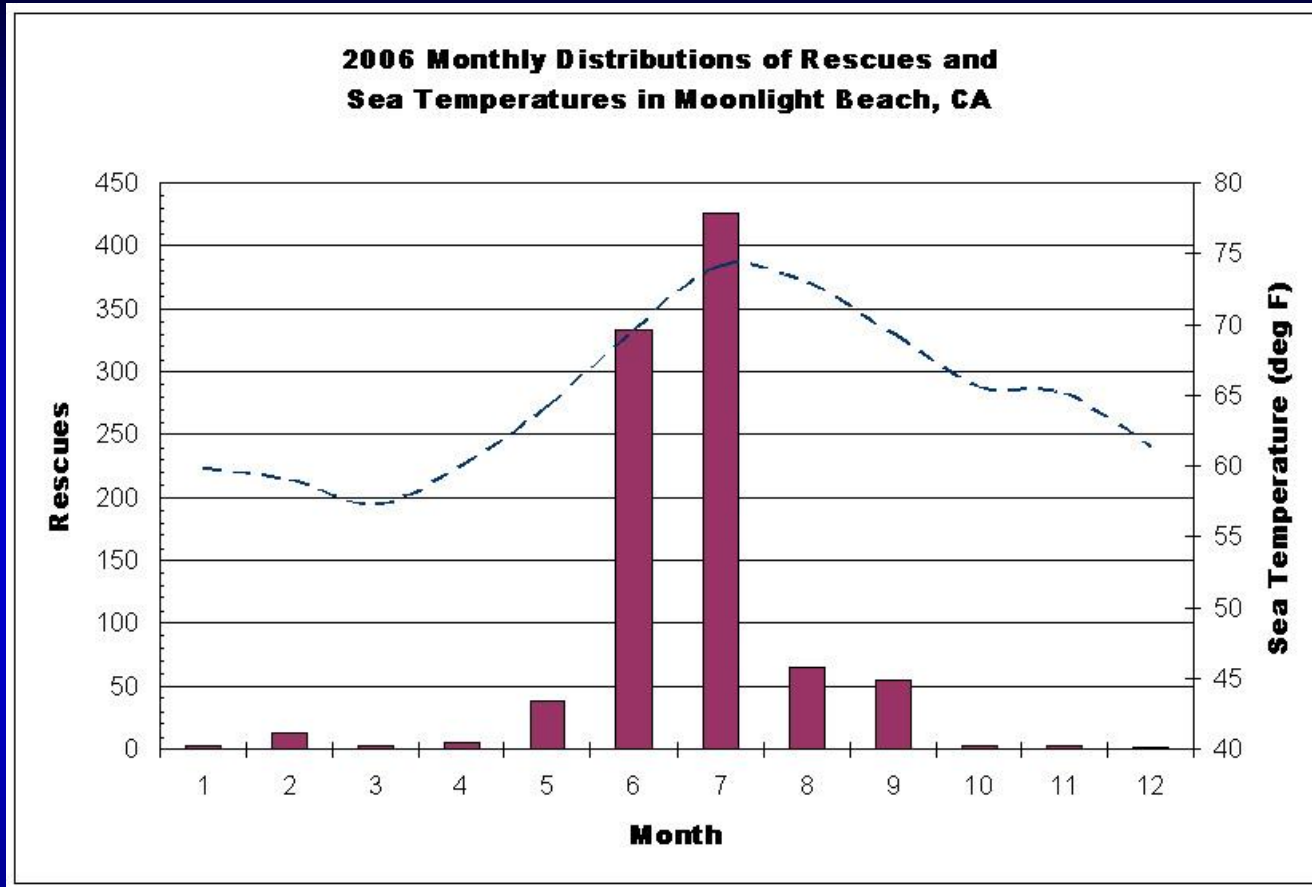
<b>Mean Waves</b>	<b>Surf Height (ft)</b>	<b>Wave period (sec)</b>
<b>Parameter/Dates</b>		
<b>CDIP (4/13/08 - 4/13/09)</b>	<b>2.88</b>	<b>12.97</b>
<b>Observed (4/13/08 - 4/13/09)</b>	<b>2.85</b>	<b>10.96</b>
<b>Mean Absolute Error (4/13/08 - 4/13/09)</b>	<b>.808</b>	<b>3.320</b>







# When is Beach Safety Critical?



**There are significant socio-economic aspects to the Rip Current Hazard Problem**



# The hazard posed by rip currents is a function of human behavior

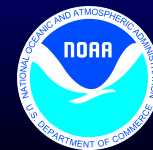


**Very high surf conditions are usually not a problem because casual swimmers tend to stay on the beach.**

**Waves of 1-5 ft are far more dangerous because both moderate rip currents and swimmers tend to be present in the surf zone.**



**High Surf at Swami's Beach, Encinitas California**



# Rip currents can appear to be safe swimming areas due to the absence of breaking waves



Rip Current at Zuma Beach, CA on 04/30/2009  
(From Trained Spotter Andrew MacArthur)





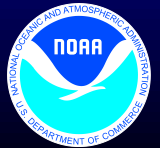
**Long period swells can be particularly dangerous because swimmers can venture far out into the surf zone during the lull between swells and be caught unprepared by the arrival of the subsequent swell and rips**



Long Period Swells



Short Period Swells



**Rip channels can be particularly dangerous for children. If they step off a sandbar into a channel they may suddenly find themselves in very deep water and being pulled seaward by a strong rip current**



# Summary Results

- 1) The surf zone and rip current observations provided by the City of Encinitas lifeguards at Moonlight Beach as well as those taken by our trained spotter at Zuma, Manhattan and Venice beaches are of sufficient quality as to be useful for scientific analysis.
- 2) The CDIP buoy/model-derived surf zone observations are comparable to those taken by the lifeguards and spotter.
- 3) Using the CDIP data as input, the two indices tested show significant skill in diagnosing rip current occurrence
- 4) A water mass discharge formulation may provide the best diagnostic indicator of rip current strength.
- 5) Rip hazard is a function of human behavior and further education of the beach-going public is needed





# Outcomes



- WFO San Diego is in the process of improving its surf zone forecast to cover three distinct zones and to update it with CDIP wave data.
- Two additional lifeguarded beaches will begin providing surf and rip current observations for the project: Newport Beach and Mission Beach.





# Questions



- 1) Should the pilot Moonlight Beach Observation program be expanded to other life-guarded beaches in Nationwide?
- 2) Should we develop an NWS “Rip-Ready” Beach program similar to the NWS Storm-Ready city/county program? If so what would make a beach “Rip-Ready”?
- 3) Should NWS train volunteers to be rip current spotters?
- 4) What information/forecasts/warnings could the NWS provide to improve beach safety?

