

Mearns Rock Time Series

How does marine life recover from a major, one-time stress, such as an oil spill? As you will learn here, the answer is not simple.

Here is a series of photographs of "Mearns Rock," a large boulder (approximately 4 feet [1.2 meters] high by 7 feet [2.1 meters] long) located in the intertidal zone at Snug Harbor on Knight Island, Prince William Sound, Alaska. The boulder is located on a very protected, south-facing rocky shoreline that was oiled during the Exxon Valdez spill in March, 1989. This section of shoreline was not cleaned after the spill. We presume that the boulder, like the rest of this shoreline, was coated by spilled oil, which was gradually removed from it by natural processes during the first year after the oil spill. (Note that we have not yet provided photos of a "control" site, a boulder on a similar shoreline that was not oiled.)

NOAA biologists have photographed this boulder--and the animals and plants growing on it--once each year (in late June or early July) during the past 15 years. Click on any photo below to see a larger image and our biologist's interpretation of what you're seeing.



1990



1991



1992



1993



1994



1995



1996



1997



1998



1999



2000



2001



2002



2003



2004

Mearns Rock in 1990

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Mearns Rock in 1991



What You See

In mid-1991, the entire boulder is covered with gold-brown *Fucus*. You can see darker species of seaweed forming an apron around the base of the boulder; the beach area surrounding the boulder (the "beach face") is also completely covered with other seaweed species. In the water behind the boulder, you can see a healthy eelgrass (*Zostera marina*) bed.

What's Happening

The boulder's condition appears to be improving, shown by the heavier covering of seaweed. One might conclude that this shoreline had recovered from the oil spill.

[1990](#) | [1991](#) | [1992](#) | [1993](#) | [1994](#) | [1995](#) | [1996](#) | [1997](#) | [1998](#) | [1999](#) | [2000](#) | [2001](#) | [2002](#) | [2003](#) | [2004](#)

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Mearns Rock in 1992



What You See

The boulder is now about 50% covered with larger, older seaweed (mainly *Fucus*). Barnacles are filling in spaces left by dying seaweed. The beach face is heavily covered with seaweed.

What's Happening

The *Fucus* that was young in the 1990 photo has aged and is now dying off. Why is it dying off?

[1990](#) | [1991](#) | [1992](#) | [1993](#) | [1994](#) | [1995](#) | [1996](#) | [1997](#) | [1998](#) | [1999](#) | [2000](#) | [2001](#) | [2002](#) | [2003](#) | [2004](#)

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Mearns Rock in 1993



What You See

Fucus now covers about 20% of the boulder's surface. Large, older plants are gone; they seem to have been replaced by young plants. Mussels are growing on the front face of the boulder (black regions). Although the barnacle areas are difficult to see in the photo, the barnacles have died back considerably.

What's Happening

The young seaweed from the 1990 photo has matured, died back, and has almost entirely left the boulder. The patches of mussels probably began as young animals in 1992, but were too small to be seen in the 1992 photo. Now that they are larger, they are more visible. NOAA biologists aren't sure why the barnacles have died back. Have you any ideas why?

[1990](#) | [1991](#) | [1992](#) | [1993](#) | [1994](#) | [1995](#) | [1996](#) | [1997](#) | [1998](#) | [1999](#) | [2000](#) | [2001](#) | [2002](#) | [2003](#) | [2004](#)

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Mearns Rock in 1994



What You See

Fucus has completely left the boulder, leaving it dominated by approximately 2-year-old mussels (black areas on the boulder) and scattered barnacles. Very little seaweed is growing on the beach face. Where did the plants go? Why aren't they growing here anymore?

What's Happening

In 1993 and 1994, something happened that caused a great reduction in the abundant marine life on this shoreline. NOAA biologists believe that the loss of seaweed, mussels, and barnacles is part of the growth cycle of the marine life, rather than due to oiling per se.

[1990](#) | [1991](#) | [1992](#) | [1993](#) | 1994 | [1995](#) | [1996](#) | [1997](#) | [1998](#) | [1999](#) | [2000](#) | [2001](#) | [2002](#) | [2003](#) | [2004](#)

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Mearns Rock in 1995



What You See

In mid-1995, about half of the mussels have disappeared, leaving smaller dark regions on the right side of the boulder. *Fucus* is making a comeback on the left side and top surface of the boulder. You can also see a resurgence of algal growth on the beach face.

What's Happening

The disappearance of the mussels may be the result of predation (perhaps by sea otters) or natural mortality. Regardless of whatever caused the boulder's plant life to die back in 1993-94, the boulder now seems to be supporting new plant and animal life.

[1990](#) | [1991](#) | [1992](#) | [1993](#) | [1994](#) | 1995 | [1996](#) | [1997](#) | [1998](#) | [1999](#) | [2000](#) | [2001](#) | [2002](#) | [2003](#) | [2004](#)

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Mearns Rock in 1996



What You See

This year, the boulder looks somewhat like it did in 1990. Young *Fucus* plants cover much of the boulder, young barnacles appear in the open spaces, and the mussels have disappeared.

What's Happening

A second "wave" of recovery has clearly taken hold.

[1990](#) | [1991](#) | [1992](#) | [1993](#) | [1994](#) | [1995](#) | [1996](#) | [1997](#) | [1998](#) | [1999](#) | [2000](#) | [2001](#) | [2002](#) | [2003](#) | [2004](#)

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Mearns Rock in 1997



What You See

The boulder is once again covered (about 80%) with the seaweed *Fucus*. There are several age groups of *Fucus* on the boulder. Young *Fucus* is growing over the top section of the boulder and adult *Fucus* is growing around the mid-portion. The beach face is again rich with seaweed. No mussels are visible and the areas occupied by the barnacles have shrunk. (Which other photo does the boulder resemble now?)

What's Happening

Starfish and sea otters may have been preying on the mussels, and a predatory snail, *Nucella*, has likely been eating the barnacles. (Although you can't tell from the photo, the *Nucella* population has been slowly growing on the boulder.)

[1990](#) | [1991](#) | [1992](#) | [1993](#) | [1994](#) | [1995](#) | [1996](#) | [1997](#) | [1998](#) | [1999](#) | [2000](#) | [2001](#) | [2002](#) | [2003](#) | [2004](#)

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Mearns Rock in 1998



What You See

The boulder is now covered with patches of adult *Fucus* and a filamentous algae, which we think is *Pilayella littoralis*. We can't see what quantity of mussels and barnacles are present because they are covered by the *Pilayella*. What other year does this scene remind you of?

What's Happening

Young plants that took hold in 1995 are now maturing.

[1990](#) | [1991](#) | [1992](#) | [1993](#) | [1994](#) | [1995](#) | [1996](#) | [1997](#) | 1998 | [1999](#) | [2000](#) | [2001](#) | [2002](#) | [2003](#) | [2004](#)

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Mearns Rock in 1999



What You See

You can see that a second crop of *Fucus* seaweed, which began to grow in about 1995-96, has matured and now nearly covers the boulder. The larger seaweed that was prominent in 1998 has disappeared.

What's Happening

The mature *Fucus* plants visible in this photo may be starting to die back. Our observations over the years suggest to us that individual *Fucus* plants survive for about 4 to 5 years.

[1990](#) | [1991](#) | [1992](#) | [1993](#) | [1994](#) | [1995](#) | [1996](#) | [1997](#) | [1998](#) | 1999 | [2000](#) | [2001](#) | [2002](#) | [2003](#) | [2004](#)

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Mearns Rock in 2000



What You See

Mature *Fucus* now covers about 10% of the boulder's surface. In addition, there is a heavy cover of a grayish, slimy seaweed (this could be any of three or four seaweed species that can look like this). As in other years, these plants may be hiding barnacles, mussels, or young *Fucus* plants from our view. The white areas on the beach face look to be large barnacle sets. Eelgrass is barely visible in the water.

What's Happening

As in the 1993 photo, the mature *Fucus* plants are again dying back. However, at this time, there is no sign of a third new crop of young *Fucus*.

[1990](#) | [1991](#) | [1992](#) | [1993](#) | [1994](#) | [1995](#) | [1996](#) | [1997](#) | [1998](#) | [1999](#) | 2000 | [2001](#) | [2002](#) | [2003](#) | [2004](#)

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Mearns Rock in 2001



What You See

This year, the boulder has a 20%-30% cover of *Fucus*. Older (brownish) plants are visible on the left section of the boulder and younger (greenish-brown) plants on the right. A whitish "bald" patch on the upper left is actually a patch of barnacles. Another bare-looking patch on the lower right corner contains barnacles (white) and small mussels (dark spots). A bright green algae, possibly "sea lettuce" (*Ulva*) droops down along the lower third of the rock face. Algae and barnacles also cover most of the cobble on the beach face.

What's Happening

During the early 1990s, marine plants and animals covered most of the boulder. Then, almost everything other than mussels disappeared by 1994. Later, the cycle of new life started up again in 1995 and 1996. We thought this might be part of a four to five year-long cycle of colonization, growth, and death. However, in 2001, six years later, the cover of marine life has not disappeared nearly as completely as it did in 1994.

So what's going on? Perhaps, over the past 12 years, intertidal marine life here has experienced variability that is decreasing with time. We may never see the boulder (and the shoreline) go bare again as it did in 1993-94. On the other hand, other things happened in the late 1990s that had not occurred in the early 1990s, including the pronounced 1997-98 [El Niño](#)

[Pacific Marine Environmental Laboratory website]. Perhaps the El Niño led to local conditions that prevented plants and animals from dying off in the late 1990s, as they did in 1993-94. How would an El Niño do this?

[1990](#) | [1991](#) | [1992](#) | [1993](#) | [1994](#) | [1995](#) | [1996](#) | [1997](#) | [1998](#) | [1999](#) | [2000](#) | 2001 | [2002](#) |
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Mearns Rock in 2002



What You See

In 2002, the boulder is dominated by barnacles, creating a 50% cover. A few large, old *Fucus* plants on the upper section of the rock make up a 10%-15% cover. None of the green algae that was present along the mid section of the rock in 2001 is present this year. A small amount of green "sea lettuce" (*Ulva*) (much less than in 2001) is visible in the lower left section of the boulder. In 1993/94, when the rock last appeared quite bare, many mussels covered the boulder; however, none are present now. Overall, the boulder location is a somewhat desolate landscape this year, with more bare rocks exposed than in previous years.

What's Happening

The die off we anticipated in 2001 is now occurring in 2002. Like in 1994/95, there is an absence of juvenile *Fucus* plants, but unlike 1994/95, the mussels are not returning. Perhaps they will in 2003?

[1990](#) | [1991](#) | [1992](#) | [1993](#) | [1994](#) | [1995](#) | [1996](#) | [1997](#) | [1998](#) | [1999](#) | [2000](#) | [2001](#) | 2002 | [2003](#) | [2004](#)

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Mearns Rock in 2003



What You See

This year, the barnacles have died back somewhat, and no new *Fucus* plants have been established. The *Fucus* plants that remain appear slightly larger this year. Sea lettuce continues to grow in the lower left corner of the boulder.

What's Happening

Conditions are very similar to 2002, with perhaps somewhat less cover of barnacles. We expected both young *Fucus* and mussels to colonize the rock by now, as they had in 1994/95, but they have not. This could be due to a lack of reproduction in both species or heavy grazing by animals such as limpets and snails. Neither are apparent.

[1990](#) | [1991](#) | [1992](#) | [1993](#) | [1994](#) | [1995](#) | [1996](#) | [1997](#) | [1998](#) | [1999](#) | [2000](#) | [2001](#) | [2002](#) | [2003](#) | [2004](#)

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Mearns Rock in 2004



What You See

In 2004, the boulder has a heavy covering of young (greenish-brown) *Fucus* plants. Barnacle density remains high on the right side of the boulder. Again this year, no mussels are visible. In the lower left corner of the boulder, the patch of sea lettuce seems to be dying back. On the beach face, the density of *Fucus* is similar to that on the boulder. In the background, an eelgrass bed (*Zostera marina*) is visible in the water.

What's Happening

Conditions in 2004 are very similar to 1996. At that time, we wrote that it appeared that a second "wave" of recovery was occurring. Now it looks like a third wave of regrowth is occurring. During the first years of recovery, there was a heavy growth of mussels; however, that doesn't appear to be the case for the second and third waves of regrowth.

We had originally thought that there was a 5-6 year period from new growth to die-off. If that was true, we should have seen a new recruitment of *Fucus* by 2001. Obviously, the new growth didn't happen for about 8 years (until 2003/2004). Thus, the time between significant recruitment events is many years, but also variable.

Questions: What do you think this Snug Harbor site will look like in June 2005, and why? Do you think the mussels will ever return?

[1990](#) | [1991](#) | [1992](#) | [1993](#) | [1994](#) | [1995](#) | [1996](#) | [1997](#) | [1998](#) | [1999](#) | [2000](#) | [2001](#) | [2002](#) | [2003](#) | 2004

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Graphing Changes in Marine Life Abundance

Want to try your hand at some marine biology? Then grab your raingear and follow the steps below to make a study of the marine life occupying a section, or **quadrat**, of Mearns Rock (a boulder in Prince William Sound, Alaska, that was oiled in 1989 by the Exxon Valdez oil spill). For your study, you'll use a series of zoomed-in photos of that quadrat. Each shows a different year from 1990 to 2004. Your goal will be to see how the percent cover of mussels, barnacles, and *Fucus gardneri* (a kind of seaweed, also called rockweed) in this study area has changed during those 14 years.



As you complete this project, you'll be using the same method used by real marine biologists. To study how marine life abundance changes from one year to the next, marine biologists sometimes section off a small plot of land that's representative of the particular habitat they're studying (for example, a rocky shoreline or a bog). They use a frame (generally a 0.25 or 0.5 square meter of rebar or PVC pipe), known as a quadrat (or "quad" for short), which they place on the ground to mark an area to study in depth. Each year, the biologists return to count the organisms or plants that occupy the area inside the quad. In the photo at right, one of our marine biologists is using a quad in his studies of the Mearns Rock site. He's trying to find out how the abundance of *Fucus*, barnacles, mussels, and other organisms changed over the years following the Exxon Valdez oil spill.

1. Before You Begin

Collect the resources you'll need:

[Open our mini field guide](#) (in a new window) You'll use it to recognize the species in your quad, estimate their percent cover, and establish the criteria you'll use to make your observations.

[Open and print out our data table](#) (in a new window) You'll use it to record your estimates of percent cover.

2. Observe and Record

Now, open the series of high-resolution photos of the same quadrat of Mearns Rock, taken each year from 1989 to 2004. As you examine each photo in the series, try to estimate how much of the quadrat that *Fucus* occupies (as a percent of the total area), how much of the quadrat mussels occupy, and how much of it barnacles occupy. Record your estimates in the data table you printed out.

[Open the photo series of the Mearns Rock quadrat](#) (in a new window)

3. Plot Your Data

Your final step will be to graph your data, so that you can see trends over time in the relative abundance of the three species in the quadrat. Your graphs will look similar to those that marine ecologists make after actually measuring the amount of cover!

[Open and print timeline graphs](#) (in a new window) You'll plot your data on these graphs.

For More Information

[See an example timeline graph](#) (in a new window) This graph was prepared by our marine biologists, and looks much like the graphs you'll prepare as you complete this project.

[View the Mearns Rock Photo Series](#) (in a new window) Read our biologists' explanations of the year-to-year changes you see on Mearns Rock.

[See photos of an example quad on Block Island, Alaska](#) Our biologists studied the plants and animals living in this quadrat to see how they recovered after the Exxon Valdez oil spill.

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