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DETERMINING AN ACCEPTABLE GATE CONFIGURATION FOR A COLONY OF CAVE MYOTIS (*Myotis velifer*) IN WILDHORSE MINE

(Continuing: Year 2)

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Determining an Acceptable Gate Configuration for a Colony of Cave Myotis in Wildhorse Mine, Year 2 of 3

Wildhorse Mine, in the Tucson Mountain District of Saguaro National Park, supports the largest bachelor colony of cave myotis bats (*Myotis velifer)* in the Tucson Mountains. From April through September this mine has been known to contain over 7,000 bats (Wolf and Dalton 2005). Wildhorse Mine was gated in 2001 to protect over 4,000 cave myotis that then inhabited the mine, and to ensure the safety of human visitors from the dangers its dangers. The gate is constructed of horizontal, angle-iron bars, and was built using the best knowledge available at the time for bat-friendly gates. Post-gate monitoring suggested that the gate was limiting colony size to about 3,000 bats. Apparently the gate restricts access and creates a "traffic jam" of bats circling behind it waiting to exit, and limits the maximum number of bats able to exit within a preferred time-frame. Before the bats returned for the summers of 2004 and 2005, a lower bar in the gate (the only bar designed to be removable) was removed to determine if colony size would increase and to observe if exit behavior changed. Bats did prefer the larger opening, and the colony size increased, although not to pre-gate numbers. Cave myotis prefer to fly near the ceiling, so in 2006, a higher bar was removed with an acetylene torch (Figure 1), and exit behavior and abundance were monitored with this configuration for the 2006 and 2007 seasons. Bat numbers increased in 2007 to about 5,000 bats, with the large open space at the top of the gate allowing more natural exit behavior. However, the large space also allows humans to enter the mine.

Our goal for this project was to determine a gate configuration that would not restrict colony size but would prevent human access. In 2008, our specific objectives at Wildhorse Mine were to:

1. Determine abundance of cave myotis throughout the season.
2. Design and install a new configuration of bars (temporary) for the top of the gate that would be more acceptable to the bats than the original 5.75" spacing, and still prevent human access.
3. Monitor exit behavior by determining the proportion of bats using each of the gate's spaces, the maximum number of bats exiting per minute, and the length of the emergence.

Methods

Bat abundance: For evening exit counts, we set up a video-camera (Sony DCR-TRV19 or TRV9) just inside the mine entrance facing the gate (the gate is about 20 feet inside the mine), and used supplemental infrared lighting (Wildlife Engineering Model IRLamp6) to obtain sufficient light for an accurate count. Because not all bats exit every night, we usually entered the mine after the end of the emergence to determine the number of remaining bats, if any.

We then obtained census data by watching the videotapes of evening emergences. Tapes were viewed, in slow motion if necessary, to obtain the most accurate counts. From these data, we created spreadsheets showing the number of bats exiting per minute, number of bats entering the mine per minute, net number exiting, and cumulative number exiting.

Exit behavior: We installed experimental bars made of foam insulation board in the upper part of the gate on 20 April as bats began arriving for the season (Figure 2). Because bats were heard hitting the foam bars during the exit count on 17 May, we changed the configuration on 31 May back to a more traditional shape, but with different widths for the top two spaces (Figure 3).

To quantify the behavior of bats exiting from Wildhorse Mine, we used methods described in Wolf and Dalton (2005). We analyzed the proportion of bats exiting through each gate space and the maximum number of bats exiting per minute. No bats flew through the small space above the top bar, therefore we designated the space below the top bar as #1.

Results

Bat abundance: We censused or estimated the number of bats at Wildhorse Mine six times during summer, 2008 (Table 1). Bat numbers peaked in July at about 4,300.

Exit behavior: Emergences lasted about 50 minutes on 15 and 25 July, the two dates with greatest observed abundance of bats in 2008. We analyzed the proportion of bats flying through each space between the bars of the gate for 15 minutes during the peaks of emergences on 17 May, and 15 and 25 July. The maximum number of bats exiting through the gate per minute was 192 on 25 July; 173 bats flew through the top space that minute.

Bats had difficulty flying through the first experimental configuration; we heard bats hitting the foam bars as they exited. No injured bats were observed, and no bats fell after hitting the foam bars, but we changed the bar configuration because it was obvious that it was difficult for bats to pass through the gate. Although the area for the bottom of Space 1 was only slightly smaller than the top, few bats used the bottom (Table 2, Figure 4). As expected, a greater proportion of bats flew through Space 1 when we changed the configuration (Table 3, Figure 5).

Discussion

Research at Wildhorse Mine over the past 10 years has shown that two parameters are important to cave myotis exiting through a gate: the width (vertically) of the space and the vertical position of the space relative to the top of the portal (Wolf and Dalton 2007). This species prefers exiting through the top of a gate, but will switch to a space much lower if the opening is substantially larger. Cave myotis are not as maneuverable as many other species, and the difficulty of flying through small spaces in a short period of time increases as colony size increases. Although we knew from observations at Wildhorse Mine that bats preferred a much larger space regardless of its vertical position, results of an experiment with bar spacing this past year at 400-Yard Mine suggest that differences as small as 1/8 inch affect exit behavior (Wolf and Dalton 2009).

Our attempts this past year to design a configuration for the gate at Wildhorse that prevented human access but allowed bats to exit at an optimum rate [using data from 1999 (pre-gate) and 2007 as optimal and near-optimal, respectively] were not successful. The first configuration experimented with the shape of spaces, and used triangles rather than the traditional rectangles in an attempt to provide a larger space vertically than the standard 5.75 inches to allow sufficient horizontal space for wingspread, but still be too small for humans to squeeze through. This gate design may have worked for a small colony, but it apparently did not allow multiple bats to simultaneously pass through.

Although bats can learn to fly through obstacles over time, we did not want to risk injury to the bats during the learning process so we took the foam bars down after hearing and watching bats hit them during the first exit count. The second bar configuration widened the top space compared to the standard, but was closer to the traditional rectangular shape. As expected, bats exited through the top space faster and in greater numbers, although not at an optimal rate. However, after consulting with cavers who helped with the exit counts, it appears that some adult humans would be able to squeeze through the top space.

Compared to an emergence in 2007, when over 5,000 bats exited in about 30 minutes with a peak rate of about 420 bats/minute, the emergence of 4,200 bats on 15 July this year took over 40 minutes with a peak rate of 190 bats/minute. Peak abundance this year was about 4,300 bats compared to 5,100 bats in 2007 (Figure 6); the decrease may or may not be due to the decrease in unrestricted flying space. In the first few years of monitoring the gate after its installation, we were reluctant to attribute changes in abundance to the gate because of the many unknown confounding factors affecting annual abundance. However, there does appear to be a correlation between increasing colony size and a larger unrestricted flight space beginning in 2004 (the first year a bar was removed). Therefore, it is likely that reducing the size of the space between the top bars led to fewer bats choosing to roost at Wildhorse in 2008. Our results lead us to conclude that it does not appear possible for a gate to both exclude humans and allow cave myotis the space needed for a colony of over 3,000 animals to persist.

Recommendations

The third and final year of this project was not funded. Until funding can be obtained for consideration of alternative management actions to prevent human disturbance but not restrict the size of the colony, we recommend that the Park remove the experimental foam bars and leave the large space at the top of the gate open to give bats maximum access. Although this configuration allows human entry, the risk for disturbance to the colony appears low at the present time. An educational sign at the gate informing park visitors of the need to protect habitat for bats may discourage exploration of the mine. Standard abandoned mine warning signs should also be installed for liability purposes. Signs should not be placed directly on the gate where they would prevent additional restriction of flight space.

Acknowledgements

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Literature cited

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FIGURES AND TABLES

Table 1. Number of cave myotis observed, Wildhorse Mine, 2008.

Date 2008	Bats
April 20	~50
May 17	1178
July 15	4307
July 25	4276
August 15	1415
September 5	102

Table 2. Proportion of bats exiting through spaces in the first experimental configuration, Wildhorse Mine, 17 May, 2008. Percentages do not sum to 100 because of rounding.

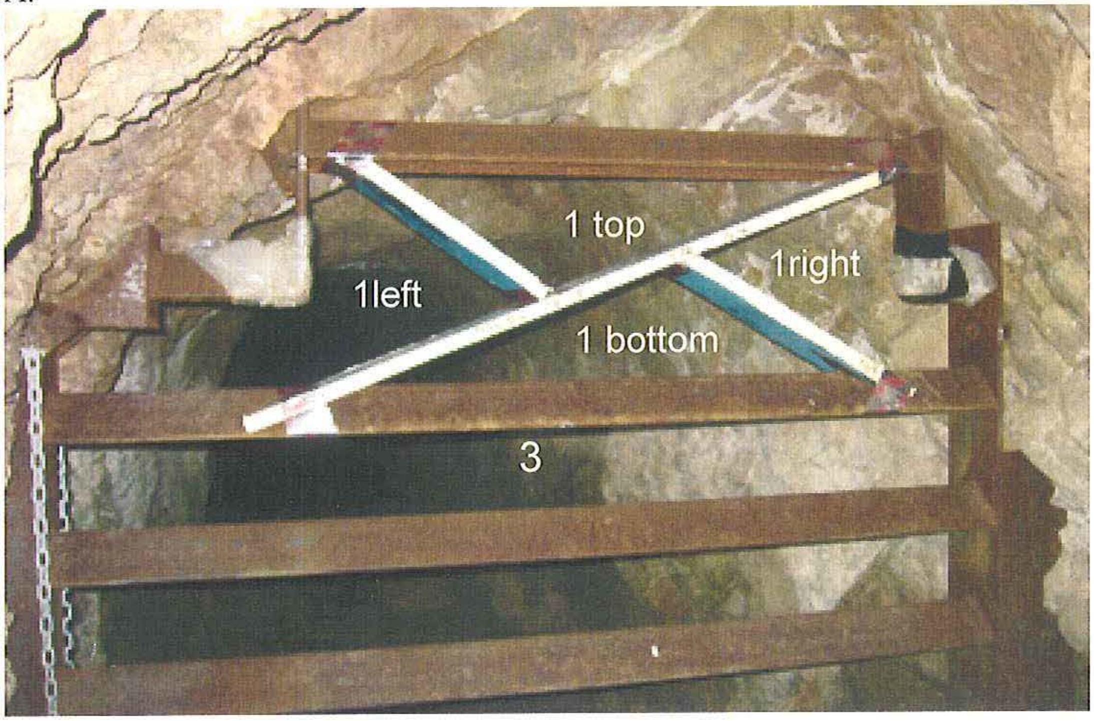
Space	% Bats
Space 1 top	64
1 left	9
1 right	9
1 bottom	4
Space 3	4
Space 4	7
Space 5	2
Space 6	0
Space 7	0

Table 3. Proportion of bats exiting through spaces in the second experimental configuration, Wildhorse Mine, 2008 (average of exits on 15 and 25 July). Percentages do not sum to 100 because of rounding.

Space	% Bats
Space 1	92
Space 2 left	3
Space 2 right	1
Space 3	2
Space 4	2
Space 5	1
Space 6	0
Space 7	0
Space 8	0

Figure 1. Gate at Wildhorse Mine, 2nd bar removed.

A.



B.

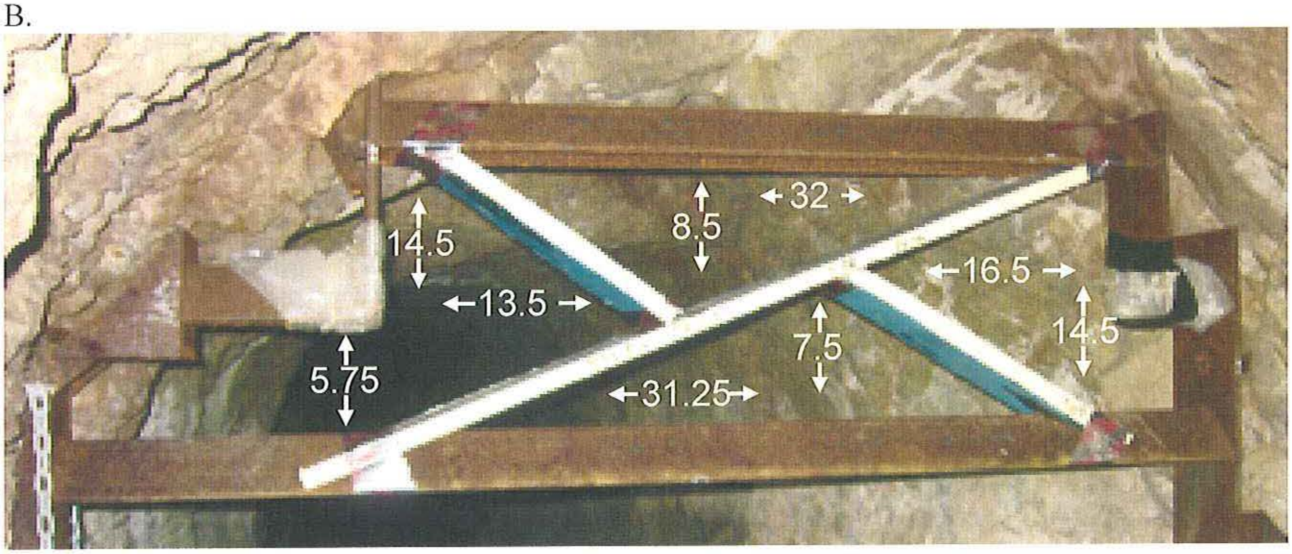


Figure 2. First experimental configuration, Wildhorse Mine, 2008. A. Space labels, B. Measurements in inches

A.

B.

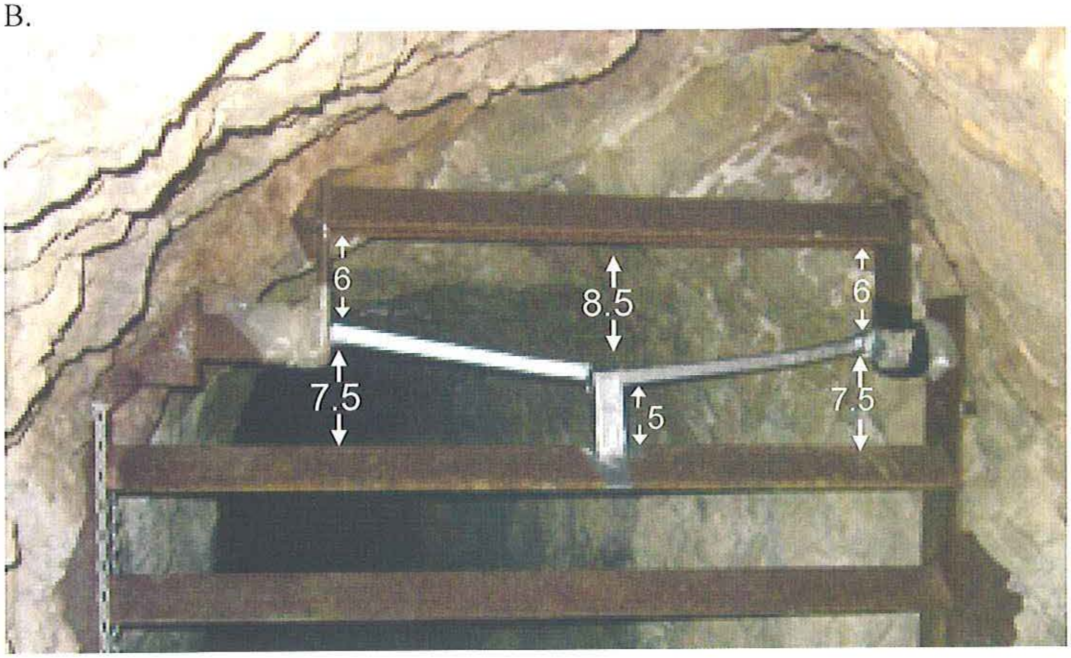


Figure 3. Second experimental gate modification at Wildhorse Mine, 2008. A. Space labels, B. Measurements in inches

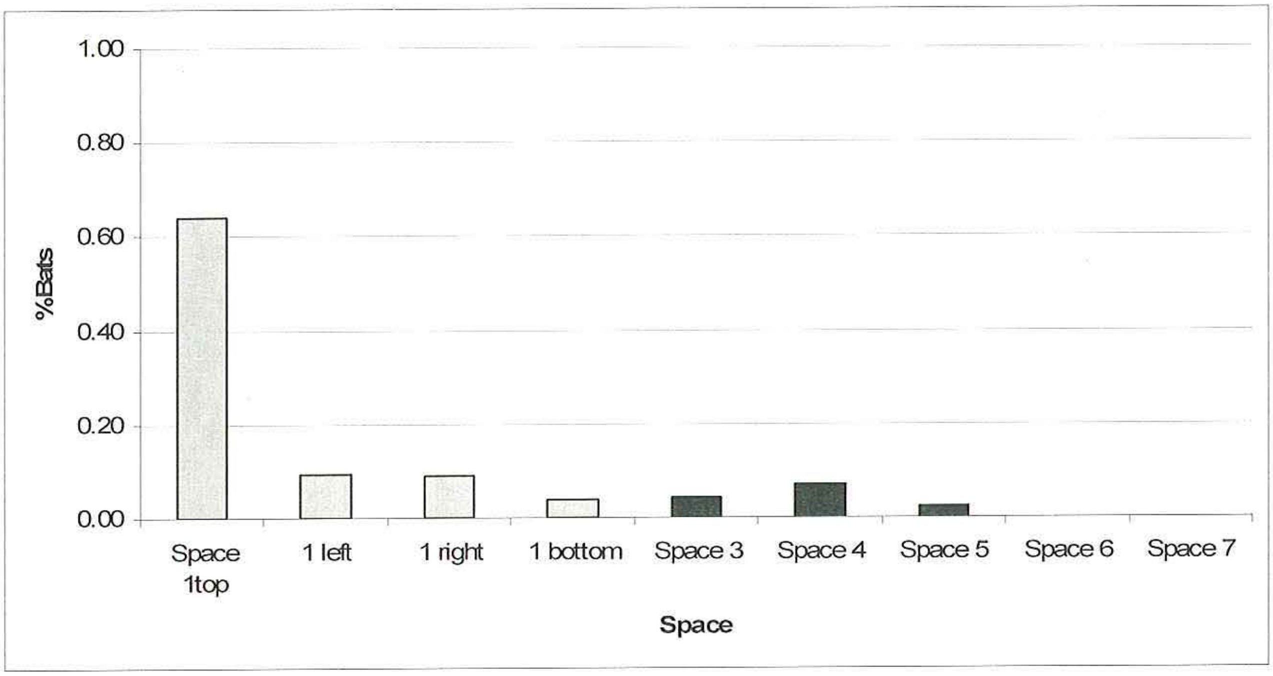


Figure 4. Proportion of cave myotis exiting through gate spaces in Wildhorse Mine, 17 May, 2008, with the first experimental bar configuration.

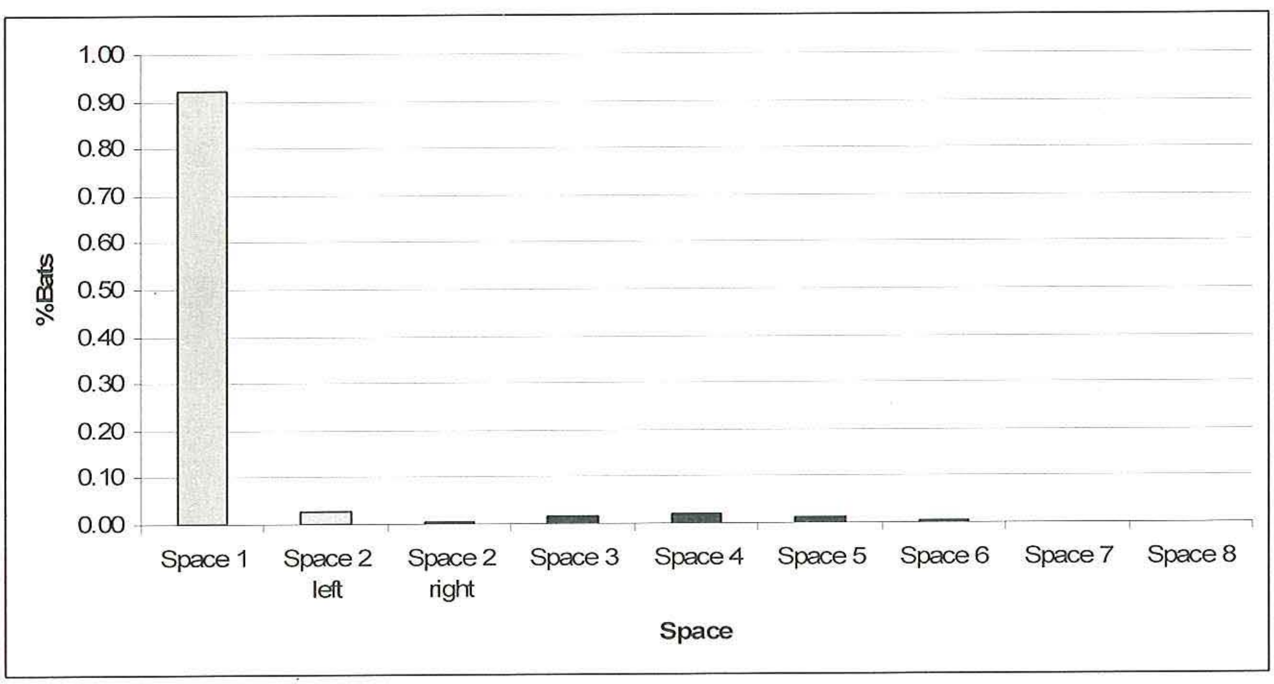


Figure 5. Proportion of cave myotis exiting through gate spaces in Wildhorse Mine, second experimental configuration. Data are averages for exits on 15 and 25 July, 2008.

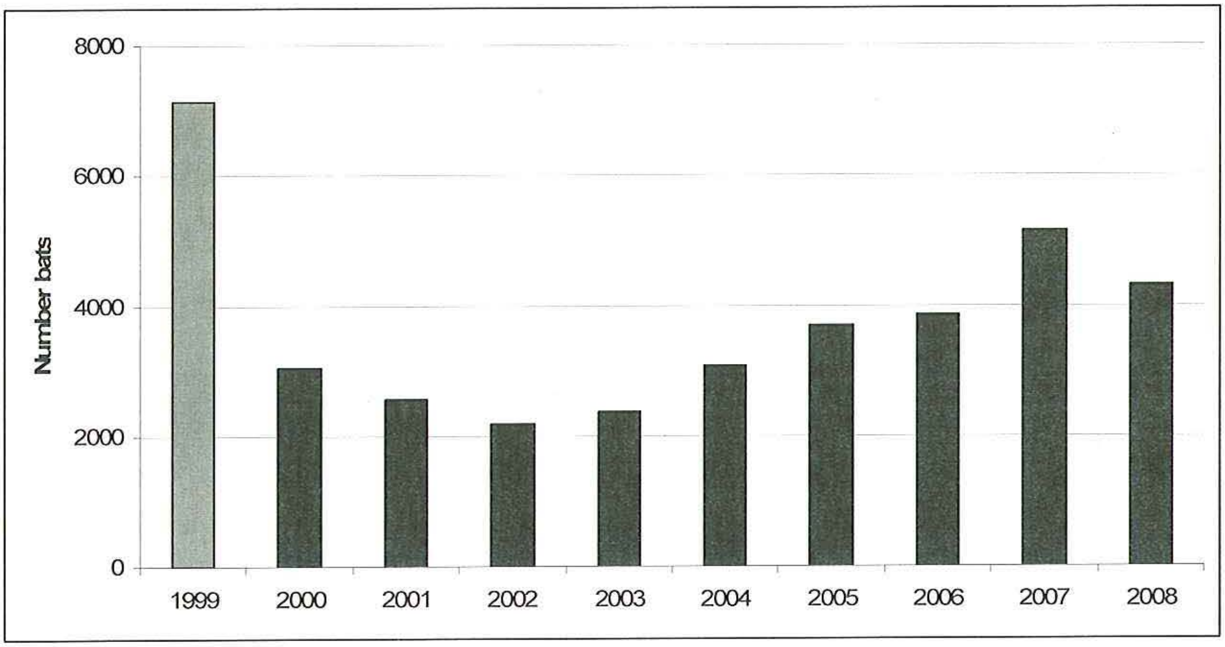


Figure 6. Maximum number of cave myotis recorded each year at Wildhorse Mine. 1999 = pre-gate, 2000-2003 = full gate, 2004-2005 = low bar removed, 2006-2007 = high bar removed, 2008 = 2 different experimental configurations