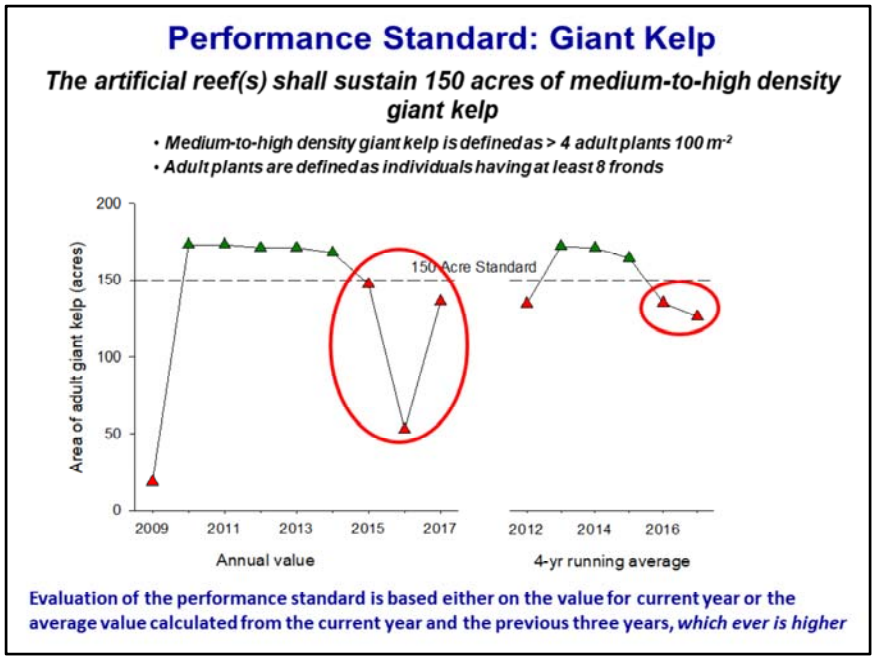
Assessing the current and future performance of giant kelp at Wheeler North Reef

Annual Review Workshop for SONGS Reef Mitigation

April 9, 2018

SONGS Mitigation Monitoring Project
Marine Science Institute, University of California Santa Barbara



- The Wheeler North Reef has failed to support 150 acres of giant kelp since 2015 and its 4-y running average has been < 150 acres of giant kelp since 2016
- Understanding the cause of this failure and evaluating whether it is likely to be an ongoing problem is important for determining whether the Wheeler North Reef is meeting its goals

Evaluating the performance of giant kelp

The artificial reef(s) shall sustain 150 acres of medium-to-high density giant kelp

Measure the density of adult giant kelp in ninety two 100 m^2 transects on Wheeler North Reef

Determine whether:

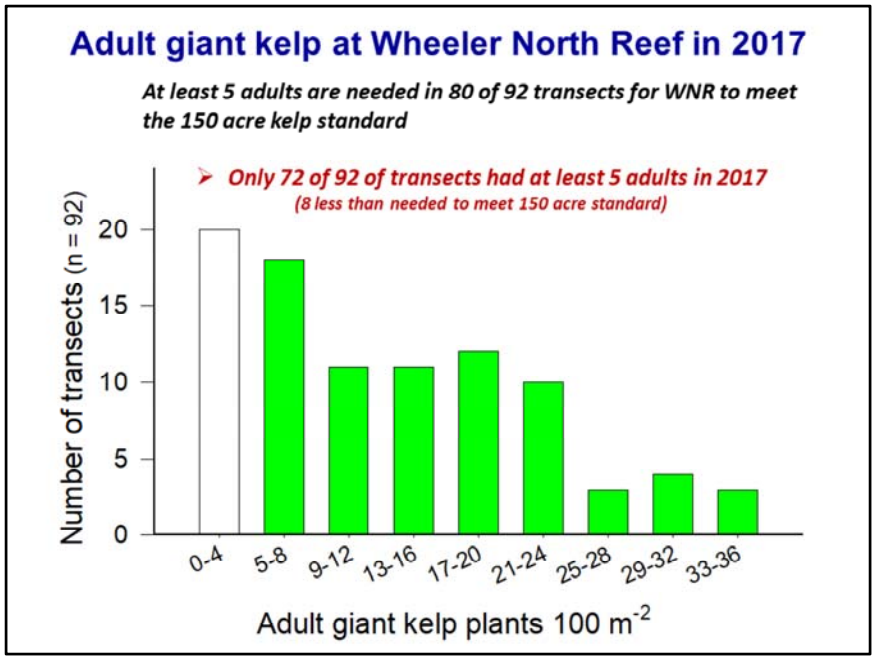
P **x 173.76 acres ≥ 150 acres**

where:

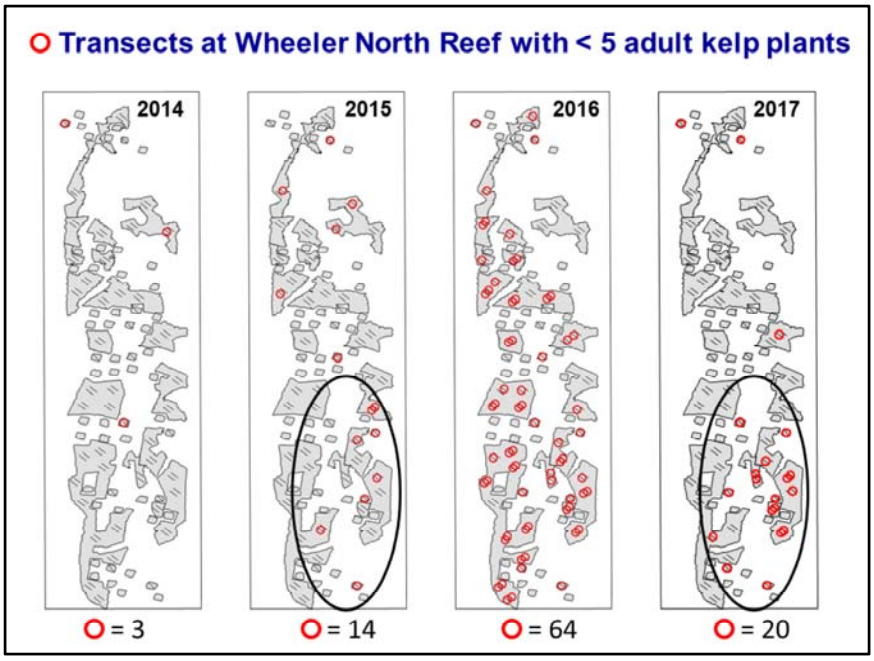
P **= the proportion of transects with 5 or more adult plants, and**

173.76 = footprint area of Wheeler North Reef in acres in the 2014 sonar survey

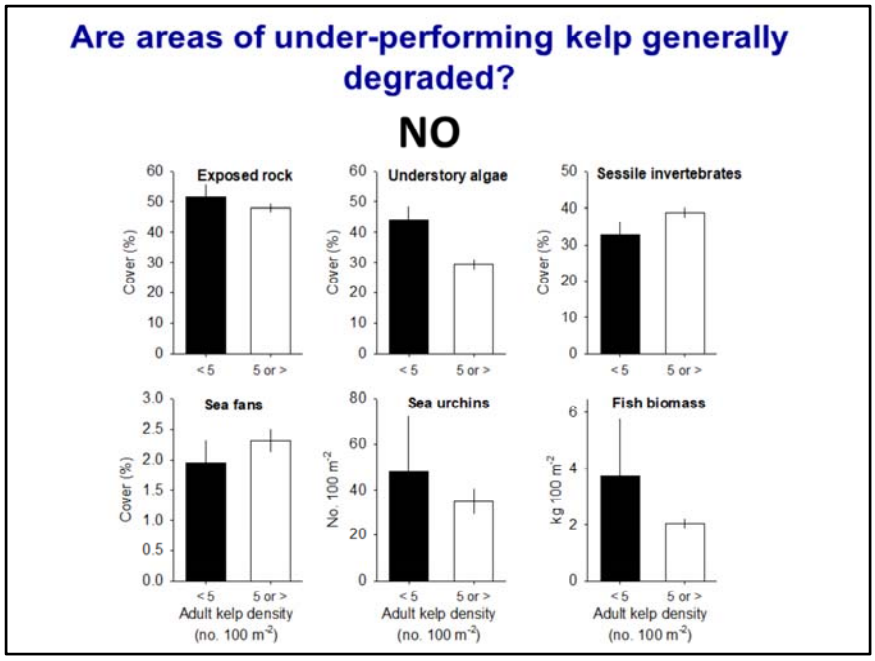
- The area of adult giant kelp on Wheeler North Reef is evaluated by measuring the density of giant kelp in 92 transects spread across the entire reef
- Using these data we calculate the proportion of transects on the Wheeler North Reef that have adult kelp densities of 5 or more plants per 100 m^2
- This proportion is multiplied by 173.76 acres (= the total footprint area of Wheeler North Reef measured in the most recent sonar survey) to obtain the total acreage of medium to high density adult kelp on the Wheeler North Reef



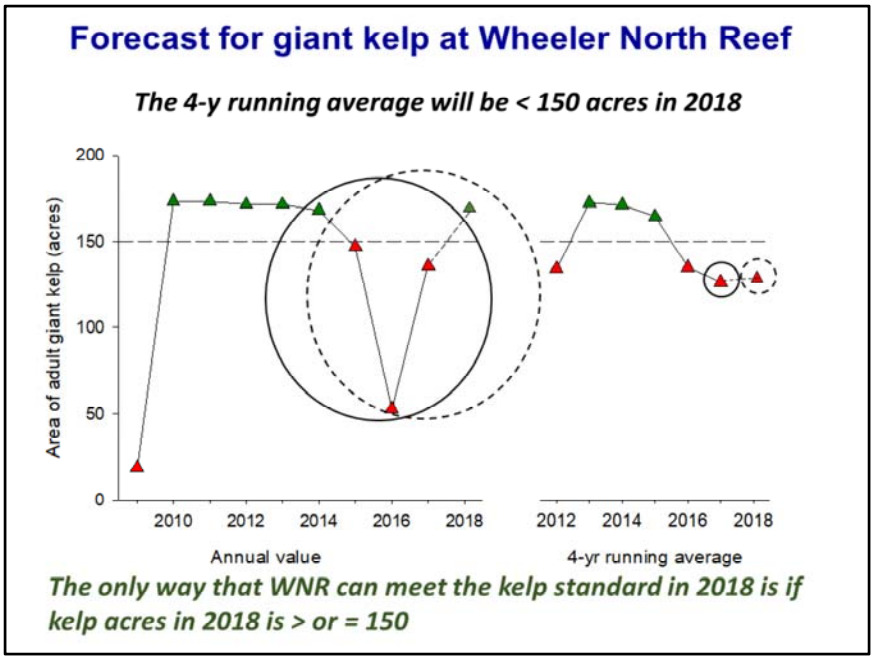
- At least 5 adult kelp plants are needed in 80 of 92 transects sampled at Wheeler North Reef in order for it to meet the 150 acre standard of medium to high density of adult kelp
- In 2017 only 72 of the 92 transects had at least 5 adult kelp, which is 8 fewer transects than that needed to meet the performance standard



- Shown here in each panel is a map of the Wheeler North Reef and the black diagonal lines show the locations of the transects.
- Red circles are shown around the transects that did not have 5 or more adults in each of the last 4 years
- All but three transects had 5 or more adult kelp in 2014
- This increased to 14 in 2015 as growing conditions started to decline and bottoming out at 64 transects during the peak of an extreme warm water event in 2016
- Cool waters returned in 2017 and the number of transects with < 5 adults declined to 20
- 17 of these 20 transects were in the southern portion of the reef and the majority of these were located inshore



- We wanted to know whether the transects with < 5 adult kelp were generally degraded and functioned poorly in other aspects or reef performance
- We found no evidence that this was the case as transects with < 5 adult kelp plants were not generally degraded
- The graphs in this slide show the mean (+/- SE) values of various attributes of the Wheeler North Reef for transects with < 5 adult kelp (black bars) compared to transects with 5 or more adult kelp (white bars)
- Transects with < 5 adult kelp were not buried in sand and had comparable coverage of exposed rock
- Other species of algae flourished while sessile invertebrates declined on transects with < 5 adults (compared to transects with 5 or more adults), which is to be expected in the absence of dense kelp
- The transects with < 5 adult kelp were not dominated by an overabundance of sea fans or grazing sea urchins and they supported a relatively high biomass of reef fish



- The Wheeler North Reef meets the kelp standard if either the area of adult kelp in the current year is > or = to 150 acres or if the average of the current year and the previous three years is > or = to 150 acres
- We know that the 4-year running average of the area of adult kelp at the Wheeler North Reef will be less than 150 acres in 2018
- This is because the 4-year average will be < 150 even if all 174 acres of the Wheeler North Reef support medium to high density kelp
- Therefore the only way that the Wheeler North Reef can meet the performance standard for giant kelp in 2018 is if the area of medium to high density adult kelp in 2018 is > or = 150 acres

What is the likelihood that Wheeler North Reef will support 150 acres of giant kelp in 2018?

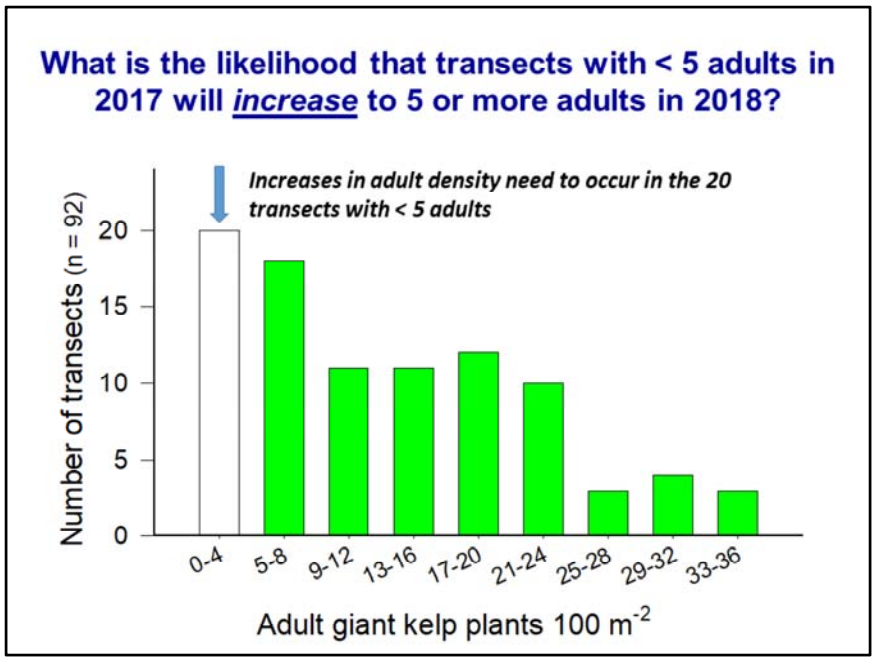
To answer this question we need to determine the likelihood that:

1. transects with < 5 adults in 2017 will increase to 5 or more adults in 2018
2. transects with 5 or more adults in 2017 will decrease to < 5 adults in 2018

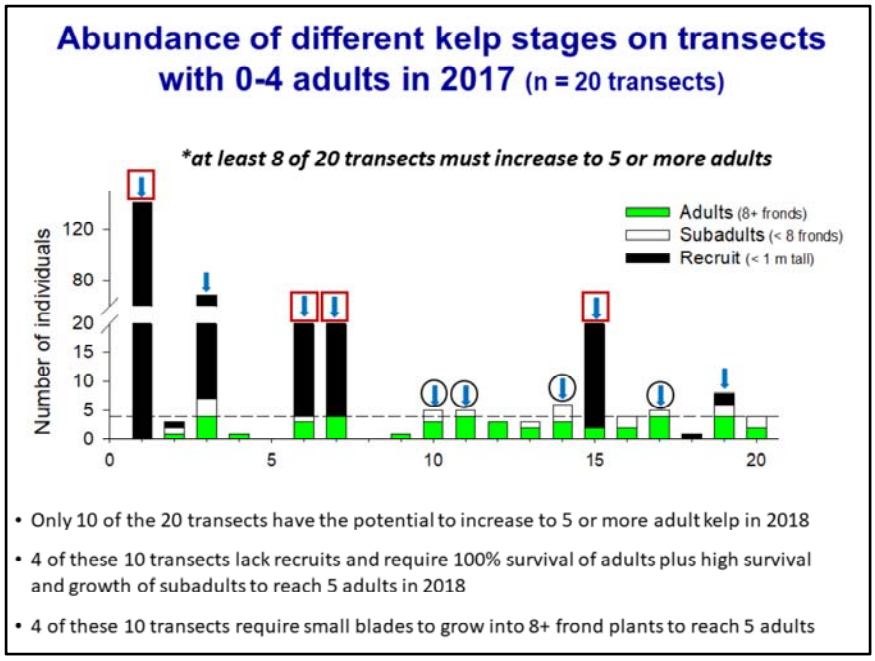
This requires data on the abundance of different kelp stages

< 1 m tall | > 1 m tall, < 8 fronds | > 1 m tall, 8 + fronds

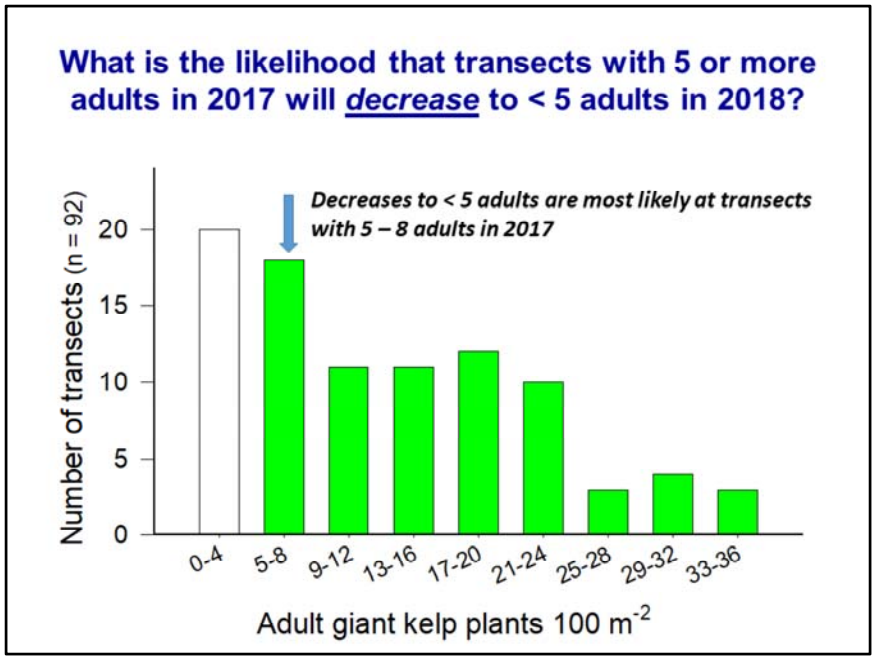
- To determine the likelihood that the Wheeler North Reef will support 150 acres of medium to high density adult kelp in 2018 we need to determine:
  - The likelihood that transects with < than 5 adults will increase to 5 or more adults in 2018
  - The likelihood that transects with 5 or more adults will decrease to < 5 adults in 2018
- This requires information on the abundance of different life stages of kelp in the transects sampled at Wheeler North Reef



- The transects with 5 or more adult kelp in 2017 that are most likely to decrease to < 5 in 2018 are those that had 5-8 adults in 2017.
- There were 18 transects in this category



- At least 8 of the 20 transescts that had < 5 adults in 2017 must increase to 5 or more adults in 2018 for the Wheeler North Reef to meet the 150 acre kelp standard
- This seems unlikely
- This graph shows the number of adult, subadult and recruit kelp on each of the 20 transects in 2017 that had< 5 adult kelp
- Only 10 of the 20 transects have the potential to increase to 5 or more adult kelp in 2018
- 4 of these 10 transects require 100% survival of 2017 adults, plus the growth of subadults into adults to reach 5 adults in 2018
- 4 of these 10 transects require small blades to grow into 8+ frond plants to reach 5 adults



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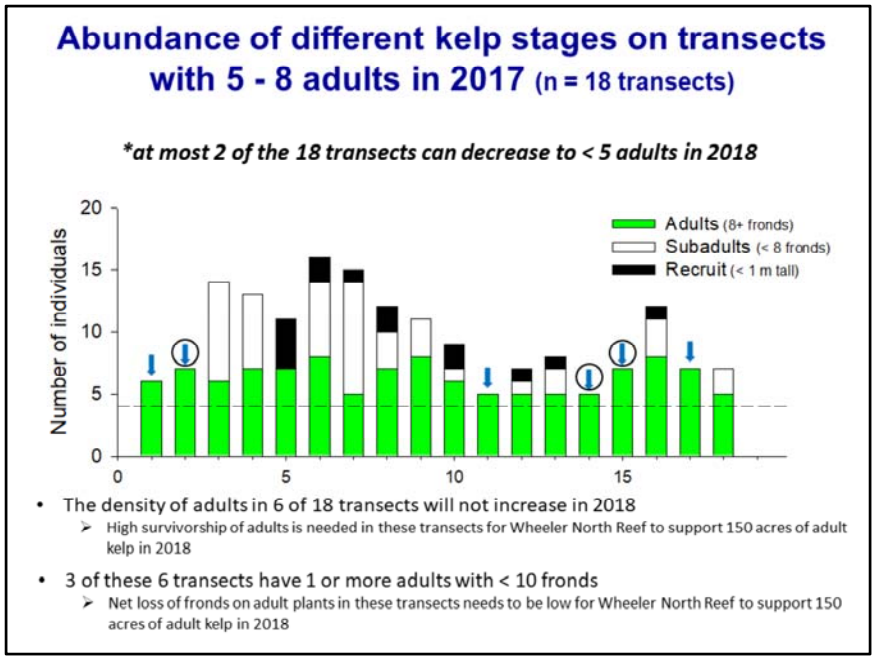
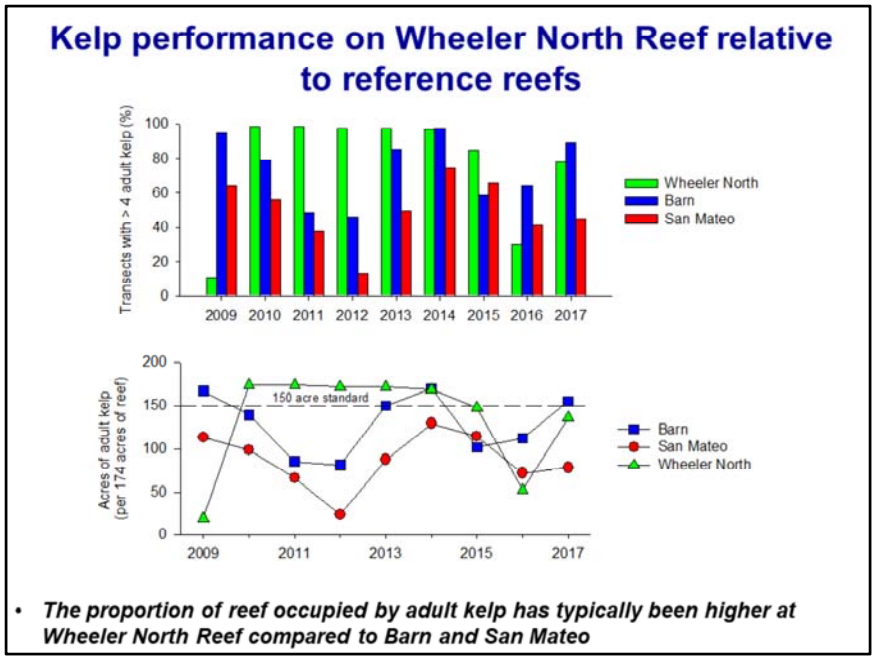


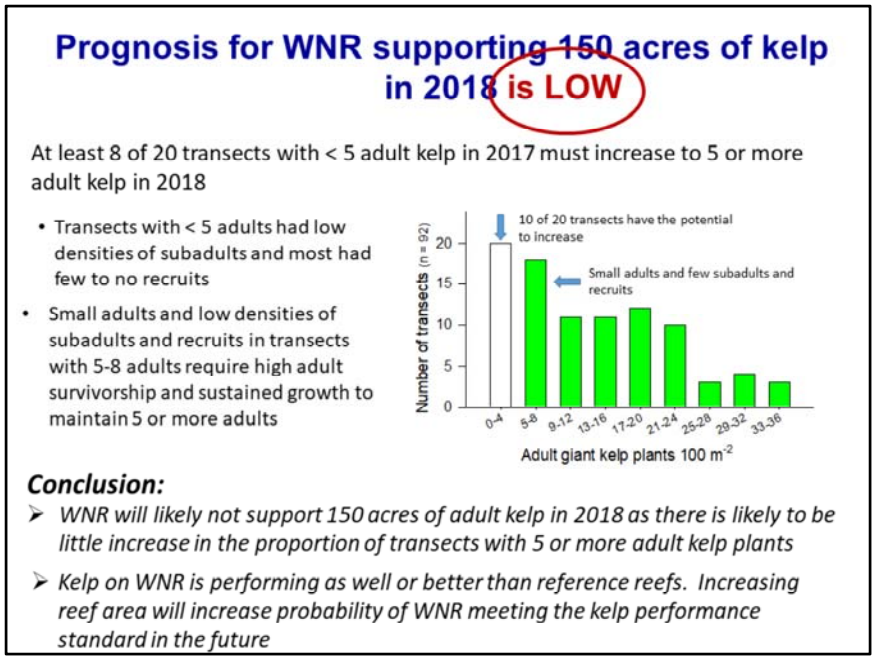
- If all 10 of the transects with < 5 adults that have to potential to increase to 5 or more adults in 2017 do so, then a maximum of 2 of the 18 transects with 5-8 adults can decrease to < 5 adults in 2018 for the Wheeler North Reef to meet the kelp performance standard
- If only 8 of 10 transects with < 5 adults increase to 5 or more adults, then 0 of 18 transects with 5-8 adults can decrease to < 5 adults in 2018
- We think that this is unlikely
- Shown here are the number of adult, subadult and recruit kelp on the 18 transects that had 5-8 adult kelp in 2017.
- Examination of these transects reveals that the density of adults in 6 of the 18 transects have no potential to increase in 2018, because there were no subadult or recruit kelp in these transects in 2017
    - 2 of these 6 transects had the minimum of 5 adults, 1 had 6 adults and 3 had 7 adults
    - Very high survivorship of the adults in these transects is needed to maintain at least 5 adults
    - Adult kelp in S. California live on average ~ 3-5 years so some mortality is to be expected
- Another way for the number of adults on these transects to decrease in 2018 is if

they decrease in size to < 8 fronds

- Fronds on a plant live on average ~4-6 months and plants often become smaller if they do not replace as many fronds as they lose.
- 3 of these 6 transects that will not increase in plant number have 1 or more adults with < 10 fronds
- The net loss of fronds on adult plants in these transects needs to be low for Wheeler North Reef to support 150 acres of adult kelp in 2018



- Comparison of the Wheeler North Reef with the kelp forests at Barn and San Mateo show that the proportion Wheeler North Reef with medium to high density kelp has most often been greater than that of the two reference reefs
- This suggests that given its size the Wheeler North Reef is doing about as well as can be expected in terms of supporting adult giant kelp



- In conclusion the prognosis for Wheeler North Reef to meet the performance standard for giant kelp in 2018 is low as there is likely to be little increase in the proportion of transects with 5 or more adult kelp plants in the coming year due to the relatively low numbers of all life stages of kelp in the 20 underperforming transects (i.e., those with < 5 adult kelp) and the low numbers of juvenile and subadult kelp in transects with 5-8 adult kelp plants.
- Kelp on the Wheeler North Reef is performing as well or better than reference reefs in terms of its proportional area that supports medium to high density adult kelp
- It is normal for only a portion of a reef to support medium to high density kelp and increasing the probability of the Wheeler North Reef meeting the 150 acre kelp standard is best achieved by increasing the area of the reef rather than trying to improve the quality of a well performing reef