August 29, 2011

To: Dr. Tim Ragen, Executive Director, Marine Mammal Commission

From: Dr. Corey Goodman

Re: Summary of analysis of Becker, Press, and Allen 2011

Introduction and overview of Becker et al. 2011

The National Park Service (NPS) scientists Dr. Ben Becker, Mr. David Press, and Dr. Sarah Allen published the paper "*Evidence for Long-Term Spatial Displacement of Breeding and Pupping Harbour Seals by Shellfish Aquaculture Over Three Decades*" in the journal *Aquatic Conservation: Marine and Freshwater Ecosystems* in April 2011. The Marine Mammal Commission (MMC), as part of its mandate to evaluate NPS data concerning the harbor seals in Drakes Estero, on July 28, 2011 invited interested parties to participate in a review of the NPS paper including its data and statistical analysis. The analysis of the Becker 2011 paper presented here – including its data, assumptions, inferences, statistical analysis, and conclusions -- is in response to the MMC invitation.

The NPS authors asked whether oyster farm activity in Drakes Estero had a long-term impact on the use of the Estero – and certain subsites within the Estero -- by the Point Reyes regional harbor seal population. The NPS authors concluded causation based on a series of correlations. According to the authors, "*three decades*" of data provide "*evidence*" that the oyster farm caused "*disturbance and displacement*" of harbor seals (i.e., environmental harm).

The key conclusion in the NPS paper is that "*higher oyster harvest*" activity led to a long-term spatial displacement of harbor seals, and in particular seal pups, out of Drakes Estero (regional scale), and away from certain subsites within the Estero (colony scale). In specific, the authors conclude that "*higher oyster harvest*" activity has led to a "*7 +/- 2%*" long-term spatial displacement of pups out of the Estero to other regional sites.

The authors used statistical multi-model analysis to assert that the models that best predict the variability in the proportion of pups in Drakes Estero all include oyster farm activity as modeled using their categorical variable OYST Hi/Low. The NPS authors previous paper (Becker et al., 2009) was criticized by the National Academy of Sciences (NAS) panel scientists (May 5, 2009) for using annual oyster harvest for the entire Estero as a proxy for specific oyster harvest activity at certain subsites (sandbars OB and UEN, the sites nearest the seal haul-out and pupping sites) during the three-month pupping season (March to May). When an earlier version of the Becker 2011 paper was presented to the MMC panel scientists on February 21, 2010, they were similarly critical of the use of annual oyster harvest, and encouraged the NPS scientists to obtain specific oyster harvest and boat trip data for sandbars OB and UEN during pupping season.

In lieu of that specific OB/UEN pupping season data, the NPS authors instead used a series of inferences to derive their categorical Hi/Low designation of oyster farm activity at OB & UEN during pupping season. The authors concluded that as oyster activity near the seal haul-out and pupping areas increased from low to high, the seals moved away from those sites and, most importantly, out of Drakes Estero.

The conclusions from this NPS scientific publication – that "*higher oyster harvest*" activity leads to long-term spatial displacement of harbor seal pups out of Drakes Estero – have important implications for policy recommendations and decisions involving the

future of the oyster farm, including the ongoing Environmental Impact Report and the decision by Interior Secretary Salazar whether to renew the oyster farm lease in 2012.

NPS originally brought this matter to the attention of the MMC in May 2007. After the NAS report two years later (May 5, 2009), the National Parks Conservation Association and Sierra Club, with the endorsement of NPS, wrote to the MMC on June 9, 2009 and requested that the Commission review the NAS findings and "*clarify for the public and policy makers the extent of concern that exists from oyster operations on harbor seals…*"

The Commission responded on July 1, 2009, indicating that it would review "*…these circumstances and their implications for harbor seal conservation.*" The Commission's decision was based on its belief that "*within the context of its duties set forth in the Marine Mammal Protection Act . . . it may have a useful role to play in this situation*."

It is thus appropriate and timely that the MMC sponsored this analysis. The MMC Terms of Reference include just such an analysis of the strengths and weaknesses of the NPS data. Those Terms of Reference state:

> *"In conducting its review, the Commission will (1) use the best available scientific information regarding human impacts on harbor seals in the estero; (2) evaluate the strengths and weaknesses of those data, including information gaps, and (3) recommend research and management activities to reduce scientific uncertainty and ensure the protection of harbor seals and their habitat."*

It is appropriate and timely to (1) examine the NPS data, (2) evaluate the NPS assumptions and resulting models, (3) replicate the NPS statistical analyses, (4) test the NPS models, and (5) consider alternative models to see if any might more robustly and with greater significance predict the variability in the proportion of pups in Drakes Estero and at certain subsites in Drakes Estero. All relevant models were subjected to the same tests for robustness and significance to determine what factors best predict the variability in the proportion of pups in Drakes Estero.

In this Summary, the major findings and conclusions of this analysis are presented. The details of the analysis are provided in the accompanying documents. This review is divided into two parts.

In part 1, NPS data were accepted and analyzed as provided by Dr. Becker (part 1, pages 5-8). [A critical evaluation of those data, claims, and assumptions is covered in part 2.] After reviewing the statistical analyses conducted in Becker 2011, the way these analyses were used, and the conclusions derived, it was concluded that the findings, rankings, and tests could be replicated using multi-variate regression analysis to standardize, visualize, and test the rankings, robustness, and significance of the various models. This statistical analysis relied on software from StatPlus (5.8 AnalystSoft Inc.).

In part 2, the data, claims, and assumptions behind the Becker 2011 paper are critically evaluated. What data are included? What data are missing? Did the NPS scientists obtain the data recommended by the NAS and MMC panel scientists? Do the data, as provided by the authors, support the various maps, claims, and figures in the NPS paper? How valid are the inferences that were used to derive the OYST Hi/Low categorical model for oyster activity used throughout the Becker 2011 paper?

I thank the Marine Mammal Commission for coordinating this review process, Dr. Ben Becker for providing the NPS data and codes required to validate and replicate the Becker et al. (2011) paper, and two faculty at Stanford University and U.C. Davis (both statisticians and one a conservation biologist) for their guidance and critical review.

Analysis of Becker et al. 2011: conclusions part 1

1. **Analysis reveals no "*evidence for long-term spatial displacement*"**
2. **No "*evidence*" that oyster farm displaced seals out of Estero**
3. **Mother Nature leads to movements of seals into & out of Estero; major factors: seals at Double Point (DP) & total regional seals**
4. **Rogue elephant seal at DP in 2003 displaced seals into Drakes Estero; Becker 2011 best models are driven by transient spike in 2003 & 2004**
5. **Top models using NPS data are far superior to Becker's best model; best P-values are 1000 times more significant than in Becker 2011**

Analysis of Becker et al. 2011: conclusions part 2

1. **Annual oyster harvest is not surrogate for UEN/OB pupping season**
2. **Seal haul-out map is misleading: seals and oysters do not overlap**
3. **Claims and maps of oyster bags in pupping areas are incorrect**
4. **Claims of zero oyster bags at OB/UEN from 2000-2004 are incorrect; CDPH records show JOC continued to harvest from UEN & OB**
5. **Inferences that drove OYST Hi/Low categorical model are incorrect; NPS did not provide conclusive data to support major model in paper**

Analysis of Becker et al. 2011: concluding comments

The MMC-directed review leads to a single, overriding conclusion: upon review, every aspect of NPS Becker 2011 collapses -- scientifically and statistically. The paper's title misrepresents the data: the statistical analysis reveals there is no evidence the oyster farm has caused a long-term spatial displacement of harbor seals out of Drakes Estero.

1. **Title says "*long-term spatial displacement*" but analysis shows transient; authors failed to note their statistics were driven by 2003 & 2004**
2. **Title says "*evidence*" oyster farm displaced seals but models fail; NPS data generates models 1000 times more significant than oyster activity**
3. **Title says "*three decades*" of data but 14 year gap; authors cherry picked 1982 & 1983 data; NPS previously denied these data existed**
4. **Analysis shows regional harbor seal population, events at Double Point, and elephant seals drive movements of harbor seals into Estero**
5. **Authors used incorrect seal haul-out maps, incorrect oyster bag maps, and misinterpreted aerial photos; NPS scientists never asked for DBOC data**
6. **Authors missed opportunity to determine if adaptive management succeeded with 1992 (oyster boats) & 1996 (kayak) management changes**
7. **Authors missed opportunity to use data to study biology of harbor seals and population dynamics; NPS scientists were too focused on the oyster farm**

Analysis of Becker et al. 2011: summary of part 1

Study area, oyster operation, and management changes

The Point Reyes National Seashore regional harbor seal population includes haul-out sites at Bolinas Lagoon, Duxbury Reef, Double Point, Drakes Estero, Point Reyes Headlands, Tomales Point, Tomales Bay, and recently Hog Island. Within Drakes Estero, harbor seals haul out at eight subsites: three lower (DBS, DEM, and L), two middle (A and A1), and three upper (UEN, OB, and UEF) estero sites. Harbor seal pupping season includes March, April, and May.

The NPS authors of Becker 2011 concluded that oyster farm activity at sandbars OB and UEN in Drakes Estero caused a "*long-term spatial displacement*" of regional harbor seals and pups from Drakes Estero – and in particular from subsites OB and UEN within the Estero. These subsites are shown on page 2 (part 1 unless otherwise noted). The seals haul out along the deep main channel, and the deep portion at the east end of the lateral channel. Oyster bags and oyster clusters are located at the west end of the UEN and OB sandbars. The east end of the lateral channel is deep whereas the west end is shallow and largely covered in dense eelgrass.

Prior to 1992, oyster farm boats were allowed to use the main channel and full extent of the lateral channel during pupping season, thus bringing them within tens of yards of the seal haul-out at OB and right over the east end of the lateral channel from which the seals haul out.

In 1992, the first of two major management changes was approved. A Federal-State inter-agency agreement among NPS, Calif. Dept. of Fish and Game, Calif. Public Health Service (now Calif. Dept. of Public Health), and National Marine Fisheries Service closed the main channel and the east end of the lateral channel to oyster boat traffic during pupping season. Since January 1992, oyster boats have used the shallow west channel to enter and park along the far west end of the lateral channel at OB and UEN during pupping season.

According to NPS, a second major management change took place in 1996 (page 24) when the NPS banned the use of kayaks in Drakes Estero during pupping season.

An aerial photo from April 26, 2011 (courtesy of Todd Pickering and John Hulls; page 3) shows the relationship of harbor seals at the OB haul-out along the east end of the lateral channel and an oyster boat at UEN along the west end of the lateral channel. The distance from oyster boat to harbor seals is approximately 750 yards. This location of the oyster boats and workers vs. the OB seals is confirmed by the 281,000 photographs from the NPS secret cameras (from 2007 to 2010) that show the oyster boats and workers at the west end of the lateral channel and sandbars, and the seals on OB at the far east end of the lateral channel (see page 20, part 2). This location of where oyster boats go is confirmed by GPS records from the boats, boat records kept since 2009.

Statistical methods

In part 1, NPS data were accepted and analyzed as provided by Dr. Becker (pages 5-8, part 1). [A critical evaluation of those data, claims, and assumptions is covered in part 2.] A multi-variate regression analysis was used to standardize, visualize, and test the rankings, robustness, and significance of the various models. This statistical analysis relied on software from StatPlus (5.8 AnalystSoft Inc.).

This multi-variate regression analysis focuses on three statistical measures: P-value, adjusted R-squared (the measure of how much variance of the dependent variable is predicted by the independent variables), and the coefficient. P-values were considered significant if they were < 0.05. The lower the P-value denotes more significant models. The R-squared, varied from 0 (i.e., the independent variables predicted none of the variance of the dependent variable) to 1 (i.e., the independent variables predicted 100% of the variance). The higher the R-squared denotes more robust models in terms of accounting for more of the variability.

We replicated many of Becker's R-squared values. However, given the variation in the number of years analyzed and the number of independent variables, we used the adjusted R-squared which adjusts for the number of terms in the model rather than the raw unadjusted R-squared. More terms will increase the unadjusted R-squared, and thus the adjusted R-squared will often be lower than the unadjusted R-squared. Finally, as in Becker 2011, the coefficients, along with the intercepts, provided a measure of the proportional change and effect size (e.g., see Becker's table 4 on page 49).

NPS data

The NPS data provided by Dr. Becker as used for Becker et al. (2011) is shown on page 5. The key dependent variable for the Becker 2011 analysis (page 6), the proportion of pups in Drakes Estero (prop.pup.de), was derived by dividing the number of pups in Drakes Estero (pup.de) by the total number of regional pups (pup.de + pupnot.de). The same logic applied to the proportion of seals (total seals = pups and adults) in Drakes Estero. The key independent variable was the categorical designation OYST Hi/Low (bags.5 for the inference of oyster bags at OB/UEN during pupping season, and 5 for the number of years with zero oyster bags at OB/UEN = 2000-2004).

The NPS data used here to test alternative models is shown on page 7. The key independent variables were total regional seals (tot.de + totnot.de; total regional pups followed the same logic) and different measures of seals or pups at Double Point. The NPS data supplied data for seals (tot.dp), pups (pup.dp), and the proportion of seals at Double Point (prop.seals.dp = tot.dp / total regional seals). The proportion of pups at Double Point (prop.pup.dp) was calculated by dividing pup.dp by total regional pups (pup.de + pupnot.de). The categorical designation "92 protocol" (before or after the 1992 management change) was used in Becker 2011 in the colony analysis but not in the regional analysis. Here we use it in the regional analysis as well.

Some important insights were derived from NPS data found in other columns (page 8). The authors claimed that the categorical designation OYST Hi/Low (bags.5) gave the same results as annual oyster harvest (oyst). This was tested. The NPS scientists have previously claimed that oyster farm disturbances have led to spatial displacement of harbor seals within Drakes Estero (Becker et al., 2009). The NPS data on disturbance rate (dist.rate) are used as is (even though we dispute many so-called oyster farm-related disturbances) to test the NPS conclusion both at the colony and regional scale.

NPS scientists apparently do not have three decades of continuous data

In the title of their paper, the NPS scientists gave the impression that they had three decades of data. In fact, their paper suggests that they have only 15 years of data, and not 30 years of continuous data. They used data from Dr. Sarah Allen's field notes from 1982 and 1983 (while she was at the Pt. Reyes Bird Observatory), then have a 14-year

gap, and then pick up with the NPS I&M-monitoring harbor seal database in 1997 to 2009. NPS has not provided the relevant pages from Dr. Allen's field notebooks.

The NPS database began in 1996 with complete data in 1997. The Becker et al. 2009 paper began with the 1997 NPS data from the NPS database. But the Becker et al. 2011 paper claimed three decades of data going back to 1982.

Dr. Sarah Allen told the Marin County Board of Supervisors on May 8, 2007 that she had over 25 years of continuous harbor seal monitoring data. Also in May 2007, NPS published "*Harbor Seal Monitoring at Point Reyes National Seashore and Golden Gate National Recreation Area*" by Marcus Koenen and Sarah Allen, a document that showed harbor seal pup data for Drakes Estero, Double Point, and Tomales Bay from 1991 to 2006 (page 24). In May 2007, I asked NPS by FOIA for all harbor seal data prior to 1997, since Dr. Allen had publicly cited "*over 25 years of continuous monitoring data …*" NPS denied my request in June 2007, saying that such data did not exist.

The Department of the Interior Inspector General report of July 23, 2008 (Investigative Report: Point Reyes National Seashore) stated:

> *"Goodman had surmised that PRNS had raw data from 1973 through the present because NPS claimed "over 25 years of [harbor seal] data" … During the hearing before the MCBS in May 2007, Allen began her presentation with the following introduction: "My name is Sarah Allen, and I'm a scientist with the NPS. And, more specifically, I've been studying the ecology of Drakes Estero for almost 30 years. …The damage of the commercial oyster operations on Drakes Estero is more easily documented, because the Park Service has over 25 years of continuous monitoring data from Drakes Estero."*

I gave the Inspector General agent a copy of the May 2007 NPS document. The DOI IG asked NPS for the data prior to 1997. The DOI IG obtained the following responses from NPS officials and scientists:

> Then-West Regional Director Jon Jarvis: *"Primary data for years prior to 1996 is not contained in the records of the NPS."*
>
> FOIA Officer Holly Bundock: *"… we have given [Goodman] everything that exists in our files."*
>
> PRNS scientist Dr. Sarah Allen: *"The data was collected prior to my working in the NPS, and they're either with PRBO when I worked there or part of my thesis. So we gave him reports that represented those data, but I didn't have a database …"*
>
> PRNS ecologist David Press: *"Any of the claims made by NPS about the impact of DBOC upon seals in DE are based upon data that has already been given to Goodman."*

Thus I was surprised in February 2010 when I read the earlier version of what became Becker, Press, and Allen 2011 as presented to the MMC and found it based upon data from 1982 and 1983 from Dr. Allen's field notes. At the February 21, 2010 MMC meeting, I asked a series of questions about the 1982 and 1983 data concerning its availability (previously denied, now it exists), quality (to count maximum number of pups and seals, 2007 has 56 surveys during pupping seasons, but 1982 and 1983 have only nine and six surveys, respectively), and relevance (as described below, 1982 and 1983 data are prior to Federal-State 1992 oyster boat protocol and 1996 kayak protocol change). NPS never responded to those questions and concerns.

In summary, NPS has only 15 years of data, 13 years of continuous data from the NPS I&M monitoring harbor seal database (1997-2009) and two years of data from Sarah Allen's field notes (1982 and 1983), with a gap of 14 years between them. In terms of examining the proportion of pups and seals in Drakes Estero vs. the total regional pups and seals, it appears from the May 2007 NPS document as if NPS scientists have appropriate data from many intervening years between 1983 and 1997, including years both before and after the 1992 (oyster boat) and 1996 (kayak) management changes.

NPS scientists should not have included 1982 and 1983 data

Based upon previous statements by the NPS scientists concerning the 2008 data, they should not have included the 1982 and 1983 data. In their previous NPS paper (Becker, Press, and Allen, 2009) entitled "*Modeling the effects of El Nino, density-dependence, and disturbance on harbor seal counts in Drakes Estero, California: 1997-2007*" in the journal Marine Mammal Science (January 2009), the authors did not include the 2008 pupping season data even though it was available to them prior to publication. They wrote:

> *"The 2008 pupping season presented an opportunity to investigate the immediate effect of a change in oyster operations."*

They went on to describe, incorrectly, the December 2007 order to the oyster farm from the California Coastal Commission that they misinterpreted as imposing the closure of the main channel and lateral channel to oyster boat trips during pupping season (the Federal-State 1992 protocols had already done just that). The NPS scientists wrote:

> *"For this reason, it is not appropriate to include the 2008 data in the models because of this large change in management."*

The NPS scientists ultimately corrected this mistake in a published "*Corrigendum*" when they wrote that the California Coastal Commission "*reaffirmed*" rather than "*imposed*" a seal protection zone in 2008.

Although their facts were incorrect, their reasoning was correct. The CCC did not impose a major management change in 2008. Rather, a group of Federal-State agencies did make a major management change in 1992 (when oyster boats were banned from the main channel and east end of the lateral channel during pupping season), and NPS made another major management change in 1996 (when kayaks were banned from Drakes Estero during pupping season). Thus, if we apply the reasoning used by the NPS scientists in their 2009 paper to the data used in their 2011 paper, we would write:

"*For this reason, it is not appropriate to include the …"* 1982 and 1983 *"… data in the models because of this large change in management.*" [Actually, two large changes – 1992 & 1996.]

Nevertheless, the NPS scientists did include the 1982 and 1983 data from Dr. Allen's field notes in the Becker 2011 paper. This data should not have been included. Prior to 1992, oyster boats could get within 10-20 yards of the seals at the OB haul-out site during pupping season, whereas since 1992, the oyster boats stay over 600 yards (and more like 750 yards) away from the seals at the OB haul-out site.

In the analysis presented here, I include the 1982 and 1983 data as did the NPS scientists. However, in the analysis of Becker's best models below, I show what happens to the significance of the OYST Hi/Low categorical designation when 1982 and 1983 data are eliminated – OYST Hi/Low is no longer significant. I also ask whether the "92 protocol" variable (which really means 1992 and 1996 protocols) accounts for any of the remaining variance in the top models used here.

Conclusion 1: Analysis reveals no "*evidence for long-term spatial displacement*"

Becker 2011 plotted annual maximum counts of total seals and pups in the Point Reyes region and Drakes Estero in Figure 2 as shown on Page 13, part 1. The authors do not plot all regional seals and pups, but rather all regional seals and pups not including Drakes Estero. [Note: the meaning of "regional seals" switches at different places in Becker 2011.] For the analysis here, regional seals is defined, as described above, as total regional seals (tot.de + totnot.de); regional pups are defined in the same fashion (pup.de + pupnot.de).

At both the regional and colony scale, the number of seals increased between 2002 and 2004 and then dropped back down in 2005. Becker 2011 does not rely on seal or pup counts per se, but rather examines the proportion of pups (prop.pup.de) or proportion of total seals (prop.tot.de) in Drakes Estero (de) relative to the total regional population of pups or seals, respectively. Those data are shown on page 14.

If we focus on 1997 to 2009 (and put aside for the moment the questionable 1982 and 1983 data), then the plot on page 14 shows that the proportion of both pups and seals remains relatively constant (in the 26% to 32% range) except for 2003 and 2004 which showed a transient increase in the proportion of both pups and seals in Drakes Estero. It is interesting to note that this transient increase coincides with the overall increase in total regional seals (page 21) seen in 2003 and 2004. It also coincides with the overall increase in total seals along the entire California coast as reported by Lowry, Carretta, and Forney (2008) from the National Marine Fisheries Service ("*Pacific Harbor Seal Census in California During May-July 2002 and 2004*" published in California Fish and Game 2008). These authors noted a 23% increase in harbor seals along all regions of the California coast from 2002 to 2004.

In summary, the graphs of either proportion of pups or seals in Drakes Estero does not show a long-term trend, and does not show "*long-term spatial displacement*," but rather does show a transient increase in 2003 and 2004. What caused that transient increase in the proportion of both pups and seals in Drakes Estero compared to the whole region? The NPS scientists concluded that the spatial displacement was caused by oyster farm activity, but NPS data do not support that conclusion, and instead point to other environmental factors as better predictors of seal movements into and out of the Estero.

Examining the NPS data for insights into what variables to test

In Becker 2011, the NPS scientists concluded that the oyster farm led to the spatial displacement of pups and total seals out of Drakes Estero. They concluded that the oyster farm caused a "*long-term spatial displacement*" of pups and seals out of Drakes Estero, whereas the data shown in the graph on page 21 suggest that some factor or factors (perhaps the oyster farm or something else) led to a transient spatial-displacement of pups and seals into Drakes Estero in 2003 and 2004.

Annual oyster harvest is plotted on page 15. As shown in part 2, annual oyster harvest is not a surrogate for oyster activity at UEN/OB during pupping season (March-May). Annual oyster harvest indeed went down in the final five years (2000-2004) of Johnson's Oyster Company ownership of the oyster farm. However, as shown in part 2, due to California Dept. of Public Health regulations (concerning where harvesting is permitted after rainfall), harvesting continued at beds #17 (UEN) and #20 (OB) during those final five years. Harvest at UEN/OB during pupping season represents ~ 5% of annual

oyster harvest for the entire Estero, and as shown in part 2, varies independently.

The NPS categorical designation OYST Hi/Low is shown on page 16. By low oyster activity, the NPS scientists meant zero oyster bags on OB/UEN during pupping season in 2000-2004. As shown in part 2, that inference was incorrect. JOC continued to farm and harvest oysters from UEN and OB during 2000-2004. Thus, OYST Hi/Low is not a proxy for oyster activity at UEN and OB during pupping season.

The two measures of oyster activity used in Becker 2011 are shown on page 17 and are shown relative to the proportion of pups and total seals in Drakes Estero on page 18. From a visual perspective, it looks as if there might be a correlation between oyster activity and the proportion of pups and seals in Drakes Estero. Below we will test if the oyster farm is a good predictor. But could there be better predictors? The answer is yes.

If we go back to Figure 2 in Becker 2011 (page 20), we see the increase in regional seals, and in the transient drop-off in 2003. Remember that Figure 2 does not show the total regional seals (i.e., in Drakes Estero and not in Drakes Estero), but rather shows only those seals and pups not in Drakes Estero.

We hypothesize that perhaps two factors are playing a role in the 2003 and 2004 time frame: total regional seals and one rogue elephant seal at Double Point in 2003.

Total regional seals went up in 2002-2004 (with a drop off in 2003), as shown on page 21. Haul-out sites along the coast are limited to isolated island sandbars or beaches surrounded by cliffs to prevent access to predators. The coastal harbor seal haul-out sites are also shared with elephant seals that dominate the harbor seals. Harbor seals alone enter into Drakes Estero. Thus we might expect that in years when there are more regional harbor seals, a disproportionately large number (particularly mothers and pups) might enter Drakes Estero to escape the crowded beaches shared with elephant seals (such as Double Point).

According to NPS documents, a single rogue elephant seal killed approximately 40 harbor seals at Double Point in 2003 and displaced many harbor seals into Drakes Estero (page 24). Becker 2011 wrote:

> *"Seals are thought to transit between Double Point and Drakes Estero (Allen Miller, 1988; Grigg et al., 2009), and in 2003 an aggressive elephant seal probably displaced numerous harbour seals from Double Point to Drakes Estero."*

We calculated how many harbor seals went into Drakes Estero in 2003. The analysis on page 26 tells us that around 50% of the pups displaced from Double Point (DP) went into Drakes Estero. The analyses of the long-term relationships among the various haul-out sites predict the same. The mean proportion of pups at Double Point (prop.pup.dp) is 0.30. In 2003, a rogue elephant seal killed 40 seals and displaced ~ 600 seals from Double Point, leaving the prop.pup.dp at 0.08. Thus, the rogue elephant seal led to a decrease in prop.pup.dp of 0.22 that equals 260 pups. If ~ 50% of the pups from Double Point went into Drakes Estero, this would equal around 130 pups displaced into Drakes Estero. This can be seen on page 24 from an NPS May 2007 document co-authored by Dr. Sarah Allen.

The proportion of pups at Double Point is shown on page 25. This graph mirrors the count data shown in the May 2007 NPS document. If we use the mean of the 2000-2002 counts, and ask where the harbor seal pups went in 2003 that were displaced from Double Point, the answer is that about 48% of the pups went into Drakes Estero and the other 52% distributed amongst the other regional sites, as shown on page 26. Double

Point partially recovered in 2004 and fully recovered in 2005.

We used the 15-year dataset to calculate the relationship between Drakes Estero and the other regional sites, and between Double Point and the other regional sites. The regression analysis gives rise to a set of relationships as shown on page 26. The analysis suggests a strong relationship between Drakes Estero and Double Point, and a strong relationship between Double Point and all of the other sites (not including Drakes Estero) combined. Bolinas Lagoon and Point Reyes Headlands all show statistically significant relationships to Drakes Estero and Double Point.

These relationships among the different regional haul-out sites predict what happened in 2003. A single rogue elephant seal at Double Point killed about 40 seals, and in so doing, displaced around 600 total seals and 260 pups, of which around 50% went into Drakes Estero and the other 50% distributed to other regional sites. Full recovery of Double Point as a harbor seal haul-out site did not take place until 2005.

If we examine the relationship of the proportion of pups in Drakes Estero vs. the proportion of pups at Double Point, we see an inverse relationship as shown on page 28. Combining the data from total regional seals and Double Point reveals the relationship with the proportion of pups in Drakes Estero as shown on page 29. Perhaps this is a better model than annual oyster harvest, or even the categorical designation OYST Hi/Low. Statistical regression analysis will help determine which if any of these independent variables – alone or in combination – is the best predictor of the variation in the proportion of pups in Drakes Estero.

To summarize, before we begin our statistical analysis of Becker's best models, and examine other alternative models, we need to consider some of the insights gained by evaluating the NPS data, as shown in Becker's Figure 3A on page 31. First, NPS did not have three decades of continuous data. Rather, they had thirteen years of continuous data, and after a 14-year gap, two points in isolation– 1982 and 1983 –from Dr. Allen's field notes. These two years were from long before the 1992 (oyster boat) management change, and before the 1996 (kayak) management change. These two years should not have been included. Second, the major trend in the proportion of regional pups or seals in Drakes Estero is the transient increase in 2003 and 2004.

Conclusion 2: No "*evidence*" that oyster farm displaced seals out of Estero

Becker's best regional models, as shown in Table 3 (page 32), all include the categorical designation OYST Hi/Low. Becker 2011 showed in Figure 6 the model effects plots with standard errors estimating the proportion of regional seal pups using Drakes Estero (page 33). The top left of Figure 6 shows the OYST Hi/Low analysis, with the proportion at nearly 34% with low oyster activity and at around 27% with high oyster activity, a 7% change. This is a visual representation of the "*long-term spatial displacement*" of "*7 +/- 2%*" of pups out of Drakes Estero with "*higher oyster harvest*" as concluded in Becker 2011.

However, this plot does not show the reader where the individual data points lie. Are the low oyster activity points all clustered around 32-34% and the high oyster activity points all clustered around 26-28%? As shown on page 34, the answer is no.

OYST Hi/Low – regression analysis. Becker's OYST Hi/Low model was analyzed by regression analysis vs. the proportion of pups in Drakes Estero (prop.pup.de). On Table 3, Becker listed OYST (OYST Hi/Low) as having an R-squared of 0.26. On its own, the OYSt Hi/Low variable is just barely statistically significant, with a P-value of 0.047. We

calculated an adjusted R-squared of 0.21. The important insight is that most of data points are effectively flat in the range of 0.26 to 0.32, including all of the DBOC years 2005-2009. The coefficient and statistical significance appears to be driven by four data points of the 15 years: 2003 and 2004 (the rogue elephant seal at Double Point), and 1982 and 1983 (the pre-1992 – and 1996 -- protocol years).

OYST Hi/Low – test #1: eliminate 1982 and 1983 (page 36). When the same analysis is run using 1997-2009 and excluding 1982 and 1983, the P-value is 0.11 (i.e., not longer significant) and the adjusted R-squared falls to 0.15. The inclusion of the data from 1982 and 1983 made the OYST Hi/Low categorical designation statistically significant – without those years, it is not statistically significant.

OYST Hi/Low – test #2: adjust 2003 and 2004 for rogue elephant seal (page 37). We can test the robustness of Becker's model by adjusting 2003 and 2004 for the rogue elephant seal. For example, based upon our previous calculations described above, we subtract the 130 pups displaced into Drakes Estero in 2003 and put them back at Double Point. When the same analysis is run using the adjusted proportions in 2003 and 2004 (and without 1982 and 1983), the P-value is 0.59 (not significant) and the adjusted R-squared is negative (i.e., zero). The relationship is completely flat – there is no relationship of OYST Hi/Low to proportion of pups in Drakes Estero.

OYST Hi/Low – test #3: eliminate 2003 and 2004 along with 1982 and 1983 (page 37). If one objects to the adjustment of 2003 and 2004 for the rogue elephant seal, the 2003 and 2004 data can simply be eliminated all together from the analysis to test the robustness of Becker's model. If there is indeed a "*long-term spatial displacement*," then it should be seen in the remaining eleven years. However, the remaining eleven years have a P-value of 0.98, an adjusted R-squared that is negative (i.e., zero), and a slope (the coefficient) that is flat. Thus, the remaining eleven years show no correlation to the variation in the proportion of pups in Drakes Estero.

OYST Hi/Low – test #4: eliminate 2003 and 2004 only; leave 1982 and 1983 (page 38). Finally, when 2003 and 2004 only are eliminated, and the remaining thirteen years are analyzed, we find no correlation of OYST Hi/Low with the proportion of pups in Drakes Estero. The P-value is 0.60, the adjusted R-squared is negative (i.e., zero), and the slope is nearly flat and insignificant.

OYST Hi/Low – summary of four tests (page 39). In summary, what drove Becker's OYST Hi/Low analysis was not oyster activity, and not the DBOC years 2005-2009, and not a long-term trend, but rather was 2003 & 2004 (probably the single rogue elephant seal), with the statistical analysis made significant by the inclusion of the data from 1982 and 1983. If 2003 & 2004 are removed from the analysis, the remaining 13 years show no significance of any kind. We conclude that OYST Hi/Low is not a good model to predict the variability in the proportion of pups in Drakes Estero. It is equally not a good model to predict the variability in the proportion of seals in Drakes Estero. This model is driven by 2003 and 2004, is not robust to these tests, and does not represent a long-term trend. Oyster farm activity does not predict the movements of seals into and out of Drakes Estero. In the next section, we consider the variables that do.

Conclusion 3: Mother Nature leads to movements of seals into & out of Estero;

major factors: seals at Double Point (DP) & total regional seals

Conclusion 4: Rogue elephant seal at DP in 2003 displaced seals into Drakes Estero;

Becker 2011 best models are driven by transient spike in 2003 & 2004

Conclusion 5: Top models using NPS data are far superior to Becker's best model; best P-values are 1000 times more significant than in Becker 2011

If the rogue elephant seal in 2003 was so important, why didn't it come up in Becker's best models? If we return to Becker's Table 3 (page 40), we see that Becker's best model combined OYST Hi/Low with Double Point. Interestingly, what is represented by "*DP*" changes in different tables. In Table 3, "*DP*" is used to designate total seal counts at Double Point. In Table 5, "*DP*" represents pup counts at Double Point. Given that Becker 2011 is based upon the proportion of regional pups in Drakes Estero (regional scale) or at certain subsites (colony scale), it would make sense to examine Double Point in terms of the proportion of regional pups (prop.pup.dp) or total seals (prop.tot.dp) at Double Point. In fact, in Table 3, subsite A is represented as a proportion. Only Double Point is represented as an absolute count. The proportional numbers are good predictors, as shown below.

Dr. Becker provided the NPS data used in his study (pages 5-8). Having explained why OYST Hi/Low is not a good model, we next examined other potential models. We found that the best models all included Double Point (DP), usually DP pups, and usually total regional seals. We examined DP seals, DP pups, proportion of pups at DP, or proportion of seals at DP. Measures of DP pups and total regional seals gave us the best models – models that were far superior to Becker's and with P-values three orders of magnitude better than Becker's best model. OYST Hi/Low is not a significant predictor after controlling for DP pups, total regional seals, and the 1992 protocols.

We plotted different models with the X-axis representing the relative ranking of models from best (#1 on left) to worst (#18 on right) and the Y-axis representing the adjusted R-squared with best (1.0 or 100% of variance predicted by model) on top and worse (zero) on bottom, as shown on page 42. The diagonal black line on the graph on page 42 represents statistical significant as measured by P-value. To the left of the line, the models are statistically significant. To the right, they are not significant.

Models from Becker 2011 (pages 42 and 44). OYST Hi/Low is barely significant on its own (P = 0.047). As shown above, this model is not significant if 1982 and 1983 are eliminated, and there is no correlation with the proportion of pups in Drakes Estero if 2003 and 2004 are eliminated. Becker's best model was OYST Hi/Low + DP seals. The adjusted R-squared = 0.42 and the P-value = 0.015. This multi-model also loses its significant if 2003 and 2004 are eliminated.

Weak models not in Becker 2011 (pages 43 and 44). All of these weak models use NPS data provided by Becker (pages 5-8). Becker, Press, and Allen (2011) claimed that OYST Hi/Low is no different from annual oyster harvest. That claim that they are equivalent is not correct. Annual oyster harvest is not significant (see also page 44). Becker, Press, and Allen (2009) claimed that disturbances impacted the movement of harbor seals in Drakes Estero. That claim is not correct. The proportion of pups in Drakes Estero vs. disturbance rate has a P-value of 0.60 and a negative adjusted R-squared (i.e., zero). That is true throughout the rest of this analysis as well. Disturbance rate does not correlate with the proportion of pups or seals in Drakes Estero, or at certain subsites (OB or all Upper Estero subsites) within Drakes Estero.

Better models not in Becker 2011 (pages 43 and 44). Several models are better than Becker's best model. Interestingly, total regional seals has a P-value of 0.004 and an

adjusted R-squared of 0.44. This variable was suggested to Dr. Becker on September 4, 2008 by National Academy of Sciences panel member Dr. Francis O'Beirn (page 48).

Best models not in Becker 2011 (pages 43 and 44). Six models were tested that are far superior to Becker's best model, all using the NPS data provided by Becker. One single-variable model, the proportion of seals at Double Point (prop.dp or prop.tot.dp), existed in one of Becker's columns (page 7). This model had a P-value of 0.0003 (two orders of magnitude, or 100-fold, better than Becker's best model) and an adjusted R-squared of 0.62. Another single-variable model, the proportion of pups at Double Point (prop.pup.dp), was simple to calculate from the numbers provided. It had a P-value of 0.00002 (three orders of magnitude, or 1000-fold, better than Becker's best model) and an adjusted R-squared of 0.75.

The top models all include some measure of seals or pups at Double Point, and many include some measure of total regional seals, or total regional pups. The top model, Double Point pups + total regional seals (P-value = 0.00003 and adjusted R-squared = 0.80) got better with the addition of the 92 protocol variable (P-value = 0.00001 and adjusted R-squared of 0.87). Keep in mind that this involves both the 92 (oyster boat) protocol and the 96 (kayak) protocol changes, and that it is only based upon two dates – 1982 and 1983. Thus, we must use caution when interpreting the importance of management changes in the proportion of seals in Drakes Estero.

Top five models– test #1: does OYST Hi/Low have any predictive value? (page 45). Becker's best variable – OYST Hi/Low – was added to each of the top five models presented here. None of our top five models on their own included OYST Hi/Low. When the five models were run using multi-variant regression analysis and an additional independent variable – OYST Hi/Low – was added, the P-value increased (i.e., significance decreased), the adjusted R-squared either decreased or did not significantly change, and the contribution of OYST Hi/Low was not significant. In contrast to the conclusion in Becker et al. 2011, OYST Hi/Low did not have a significant impact on the proportion of pups in Drakes Estero.

Top five models– test #2: what if 2003 and 2004 are eliminated? (pages 46 and 47). We previously showed that if we eliminate 2003 and 2004 from the OYST Hi/Low model, that the remaining thirteen years are not significant. An important test of the top models is to do the same test and determine how robust are these models without 2003 and 2004 (i.e., without the rogue elephant seal at Double Point in 2003). If the top models represent a significant long-term pattern, then they should still be significant with only thirteen of the fifteen years. Becker's best models failed that test. Becker's best models (with OYST Hi/Low) depend on 2003 and 2004 whereas the much better models (e.g., DP pups + total regional seals + 92 protocols, as shown on page 46) do not. When 2003 and 2004 are eliminated from the top model (DP pups +total regional seals + 92 protocols), the P-value is still 0.005 and the adjusted R-squared is 0.65, values that are far more significant than Becker's best model with 2003 and 2004 included.

Effect size of best models (pages 49 and 50). In Table 4 in Becker 2011, the NPS scientists claimed that the effect size of the effect of "*higher oyster harvest*" using the OYST Hi/Low analysis was 65 +/- 18 pups displaced out of Drakes Estero. They represented the Double Point data per 100 seals. Since around 600 seals were displaced from Double Point by the rogue elephant seal in 2003, we can calculate the effect size of Double Point from their Table 4 as around 60 +/- 30 pups, not so different from the OYST Hi/Low numbers.

We calculated the proportional change of pups and the effect size of pups in some of

our top models. In the top models, the effect size of the Double Point pups are in the range of 100 pups and of total regional seals in the range of 100 pups. The proportion of pups at Double Point has an effect size of 170 +/- 26 pups. Thus, the variations in Mother Nature – the total regional seals and interactions with elephant seals at Double Point – can account for movements of hundreds of pups into and out of Drakes Estero.

Ranking of models is similar for proportion of seals as for proportion of pups

We also examined the proportion of seals in Drakes Estero (pages 52 and 53). As with the proportion of pups, OYST Hi/Low was not significant when 2003 and 2004 were eliminated. As with the proportion of pups, our best models were significantly better and relied on variables involving total regional seals and the seals or pups at Double Point. Interestingly, the adjusted R-squared is not as great. It may be that the major movements of harbor seals are driven by the mother seals and their pups.

The lessons learned from the analysis of total seals in Drakes Estero is similar to what was learned from the analysis of pups. The best models mostly include total regional seals and some measure of pups or seals at Double Point. As shown on page 54, OYST Hi/Low has no impact on the best models. Finally, OYST Hi/Low is driven by 2003 and 2004, whereas the best models are robust with or without those years.

Proportion of pups and seals at subsite OB

The seals & pups at OB are the closest to the oyster operation (750 yards; page 55) and have been the focus of many NPS claims since 2007 concerning the impact of the oyster farm on the seals. Does oyster activity correlate with fluctuations at OB? Answer: no. As with the analysis of pups and seals in Drakes Estero as a whole, so too at subsite OB, the major influences are total regional seals and pups at Double Point (page 56).

Just as with seals and pups of Drakes Estero, so too the seals and pups at subsite OB, the haul-out site closest to the oyster boats, do not correlate with OYST Hi/Low and do not correlate with the disturbance rate. Rather the seals and pups at OB do correlate with Mother Nature – total regional seals and in some instances Double Point pups outside Drakes Estero along the PRNS coast.

Proportion of pups at Upper Estero (subsites UEN, OB, and UEF)

We also tested the proportion of pups in the Upper Estero (subsites UEN, OB, and UEF) as a proportion of Drakes Estero pups or of total regional pups. We obtain the same relative results regardless of whether we view the Upper Estero from the perspective of the Drakes Estero seals or the total regional population. Does oyster activity correlate with fluctuations in the Upper Estero? Answer: no. As with the analysis of pups and seals in Drakes Estero as a whole, so too at the Upper Estero, the major influences are total regional seals and pups at Double Point (page 57).

Just as with seals and pups of Drakes Estero, and seals and pups of OB, so too the pups at the upper estero sites (UEN, OB, & UEF) do not correlate with OYST Hi/Low and do not correlate with the disturbance rate. Rather the pups at the upper estero sites do correlate with Mother Nature – total regional seals and Double Point pups outside Drakes Estero along coast.

Analysis of Becker et al. 2011: summary of part 2

Conclusion 1: Annual oyster harvest is not surrogate for UEN/OB pupping season

Annual oyster harvest decreased during the final five years (2000-2004) of Johnson's Oyster Company, but did activity at UEN & OB decrease similarly, and go to zero, as claimed in Becker 2011? The answer is no. Annual harvest is not a surrogate for oyster activity at UEN and OB during pupping season.

Becker et al. (2009) relied on annual oyster harvest as a proxy for oyster activity at UEN and OB during pupping season. The NAS panel report on May 5, 2009 was critical of the use of annual oyster harvest as a proxy (page 4). At the MMC panel meeting on February 23, 2010, Kevin Lunny, owner of Drakes Bay Oyster Company (DBOC), was critical of both papers by the NPS scientists -- Becker et al. 2009 and Becker et al. 2011 – for their reliance on annual oyster harvest (page 5). Lunny said:

> *"We've never been asked a single question. And those data are all available."*

Dr. Ben Becker responded to Lunny (page 6):

> *"I fully agree with Kevin that it would be great if we had better measurements, right time period, and all this other stuff. But we also need to think about, we need a dataset that we can go all the way back to '97, or '82 in the case of the new analysis, that is consistent. Sometimes there's a trade-off between accuracy and consistency."*

Gordon Bennett responded to Lunny (page 6):

"… what strikes me is that the information that's been revealed that exists today is really important and could have really informed Ben's papers. We're only hearing it revealed today, for the last over a year we've heard criticisms of the use of the annual production harvest number, but only criticisms, without knowing that the helpful information is actually there and could be used. …Ben could've used that information. This is great."

Lunny responded to Bennett (page 7):

"Just a quick response to what Gordon said, that we somehow haven't shared those data. That sounds like there's an assumption that we knew Becker was working on another new report. We would have loved to collaborate."

Lunny offered the MMC and NPS scientists his data on February 23, 2010. The MMC recommended that the NPS scientists obtain these data from Lunny. Becker, Press, and Allen submitted their paper on October 14, 2010. Between those two dates, Becker never asked Lunny for the DBOC data. The NPS scientists did not inform DBOC or MMC that the paper was submitted in October 2010, when it was accepted in February 2011, or when it was published online in April 2011. Amy Trainer of the Environmental Action Committee of West Marin first announced the publication of the Becker 2011 paper to a local newspaper in April 2011.

Oyster harvest and oyster harvest boat trips during pupping season (March – May). DBOC has been keeping specific data on oyster harvest and harvesting boat trips since they took ownership in 2005. The data for UEN and OB during pupping season are shown on page 8. Only two trips took place during pupping season in 2007 on March 24 and 30. The next oyster harvest trip to the west end of the lateral channel was not until August 7. The number of OB/UEN oyster harvest boat trips was highest in 2006, 2009, and 2010. Note oyster harvest from bed #17 (UEN) in 2005 (relevant for page 40).

The annual oyster harvest, UEN/OB oyster harvest during pupping season (March-May), and UEN/OB boat harvest trips during pupping season are listed on page 9 for DBOC years 2005 to 2009. A regression analysis of annual oyster harvest to UEN/OB oyster harvest during pupping season has a P-value of 0.74 (not significant) and an adjusted R-squared that is negative (i.e., zero). Similarly, a regression analysis of annual oyster harvest to UEN/OB boat harvest trips during pupping season has a P-value of 0.65 (not significant) and an adjusted R-squared that is negative (i.e., zero). As a control, we examined the relationship of UEN/OB harvest during pupping season with boat harvest trips during pupping season. For this analysis, the P-value is 0.005 (highly significant) and the adjusted R-squared is 0.98. Boat harvest trips and the amount of oyster harvested from those locations are highly correlated.

The data are clear. There is no relationship between annual oyster harvest vs. oyster activity at UEN/OB during pupping season. The MMC encouraged Becker in Feb 2010 to obtain these data, but he did not.

Why are the numbers of boat harvest trips so low during pupping season in 2007? In early April 2007, Superintendent Neubacher told Supervisor Kinsey that NPS had overwhelming data that DBOC was disturbing the harbor seals and was considering criminal charges. As a result of this conversation, Kevin Lunny told Jorge Mata (DBOC foreman) to stop entering the west end of the lateral channel and stop accessing the oyster beds at UEN during the pupping season. As of early April 2007, DBOC workers had already made two harvest trips to bed #20 (OB) on March 24 & 30, 2007. They did not go back to the lateral channel to harvest from bed #20 (OB) until August 7. In the intervening months, DBOC workers report having made a few maintenance trips to the north end of OB but did not enter the lateral channel from the west channel (page 10).

Conclusion 2: Seal haul-out map is misleading: seals and oysters do not overlap

The harbor seal haul-out map in Figure 1 of Becker 2011 is misleading because it shows the seals and oysters overlapping when in fact the oyster boats, workers, and bags stay to the west end of UEN and OB while the seals stay to the east end of OB along the east end of the lateral channel.

At the February 23, 2010 MMC panel meeting, Dr. Sarah Allen (the senior author of the Becker 2011 paper) stated (page 13):

> *"… in fact, they* [the harbor seals] *used to go up into Barries Bay when that channel was deeper. That channel* [i.e., the lateral channel] *has narrowed so they can't access it. But there aren't high enough sandbars and deep enough channels other than the ones they're using."*

Kevin Lunny responded (page 13):

> *"Sarah's exactly correct, the lateral channel used to be deeper and it gave the harbor seals access to Barries Bay. And that has since completely closed off. The lateral channel is far shallower now. You'll look at the eelgrass maps and you'll see that in the past decade or so, eelgrass has filled in the lateral channel and we don't see the harbor seals hauling out along the lateral channel now. You know, the concern is that because of the shellfish aquaculture, or not, I just wanted to bring that out, because that has dynamically changed and shut off that access at the end of the lateral channel into Barries Bay. … as we saw yesterday on the tour, it's very very shallow."*

Dr. Allen responded (page 13):

> *"I concur with what Kevin's noted about changes to the lateral channel, but the seals are still using the lateral channel to that one little side channel that cuts across the north top. …I agree, there is eelgrass there and certainly some morphological changes."*

Dr. Allen's statements to the MMC panel concur with the NPS 2007 Drakes Estero eelgrass density map (page 14) that shows dense eelgrass in the west half of the lateral channel, and significant eelgrass in over 50% of the east half of the lateral channel as well. As Dr. Allen said, the harbor seals like to haul out from deep channels to high sandbars, and across the length of the lateral channel, only OB along the east end of the lateral channel meets those criteria.

Why does Figure 1 in Becker 2011 show the harbor seal haul-out area extending the entire way along the lateral channel? We do not know.

With Dr. Allen's guidance, on Dec 12, 2007, the California Coastal Commission instituted a Seal Protection Zone (or Area) with significant set backs from the seals (page 17). This map does not support Becker's Figure 1.

Dr. Allen's masters thesis from 1988 contains a map showing the harbor seal haul-out area on OB at the east end of the lateral channel (page 18).

The harbor seal haul-out map used by Tom Moore (CDFG) on May 20, 1991 and by the January 1992 Federal-State inter-agency agreement showed harbor seals hauling out along the east end of the lateral channel (page 19).

Finally, the 281,000 photographs from the NPS secret cameras from May 2007 to June 2010 show the OB seals at the east end of the lateral channel, well over 600 yards away from the oyster boats and workers at the west end of the lateral channel (page 20).

During the MMC review process, we repeatedly asked for photographic data supporting the harbor seal haul-out boundary shown in Figure 1 of Becker 2011.

We asked Dr. Becker:

> *"Please provide the aerial photographs and other documents, and data that were used to derive the "seal haul-out area" line drawn in Figure 1. If any of the data used to derive the "seal haul-out area" line drawn on Figure 1 is a decade or older, provide photographs showing the extent of eelgrass coverage of the lateral channel at that time."*

Dr. Becker responded:

> *"Layer created by Author's personal experience over 30 years and writing several reports on harbor seals in Drakes Estero. Some additional DFG and NOAA reports on MMC website include maps of haul out areas."*

Thus, NPS provided no photographs of seals hauled out along the west end of the lateral channel. Rather, we were told that the map is based upon Dr. Allen's 30 years of experience. But this answer is contradicted by Dr. Allen's map in her 1988 masters thesis, the 1991-1992 NPS-NOAA-CDFG map, and the 2007 California Coastal Commission map.

In summary, NPS provided no data to support their harbor seal haul-out map in Figure 1. This map is misleading. The seals and oysters do not overlap.

Conclusion 3: Claims and maps of oyster bags in pupping areas are incorrect

NPS officials and scientists have been showing maps of oyster bags in publications and public presentations, and making verbal claims in public presentations, since 2007. NPS officials and scientists have claimed that oyster bags have been placed in harbor seal haul-out and pupping areas. This claim is made in the oyster bag part of the map in Figure 1 in Becker 2011. What NPS data support this claim?

The NPS map for oyster bag areas (i.e., aquaculture material) for 2007 and 2008 provided by Becker is shown on page 23. The map shows large areas of oyster bags on UEN and OB along the west end of the lateral channel. These are beds #17 and #20, respectively. What are the data supporting the small oyster bag areas drawn away from (i.e., east and south of) bed #17? These would require oyster workers dragging oyster bags an extra 500 yards across sand and mud. Why would the oyster workers do that? These polygons form the basis of the NPS claim that oyster bags are in or near pupping areas. During the MMC review process, given that some of these polygons appear on Figure 1 in Becker 2011, we asked repeatedly for photographic evidence of these oyster bags in 2007 and 2008 and none were provided.

Becker's Figure 4 represents some of these data in a graphic form showing a very strong correlation between acres of oyster equipment near seal haul outs (i.e., UEN and OB) and annual oyster harvest (R-squared = 0.91; P-value < 0.00). Having been criticized by both the NAS and MMC panels for using annual oyster harvest as a proxy for oyster activity at UEN/OB during pupping season, Figure 4 was Becker's attempt to justify the use of annual oyster harvest as a proxy for oyster activity at UEN and OB. However, Figure 4 used incorrect numbers.

Brown and Becker March 2007 Trip Report. In Figure 4 in Becker 2011, the NPS scientists claimed 22 acres of oyster bags in 2007. Becker 2011 claimed these data came from aerial photos (Table A1). When we repeatedly asked Becker for the 2007 photos, he finally acknowledged that the data came from "*on the ground GPS*." The "*on the ground GPS*" came from the Don Brown and Ben Becker Trip Report of 3/13/2007 (page 25). However, that Trip Report measured 10 acres, not 22 acres, was done when some oyster bags were floating or under water (as indicated by the photos attached to the Trip Report), and reported that "*some site areas estimated from a distance*." The Trip Report does not read as if the GIS specialist got out of the boat at low tide and walked around the UEN and OB sandbars mapping the oyster bag areas using GPS.

Although the Becker March 2007 Trip Report claims that some oyster bags or oyster equipment was seen close to harbor seal haul-out sites, it is difficult to know on what basis these statements were made. The only photographs included with the Trip Report show bags tethered by ropes floating in the water, or bags at a great distance with water between. No photographs were provided with this Trip Report that showed oyster bags near haul-out or pupping areas. In fact, NPS has never provided a single photograph showing oyster bags in seal haul-out sites as they have repeatedly claimed.

Aerial photographs used by NPS for oyster bag maps. No NPS aerial photos exist for 2007. Aerial photos for 2008 provided by NPS do not support these small areas away from beds 17, 20, 14, & 15 and claimed to be near seal haul-out areas (page 26). No photos have been provided by NPS that clearly show oyster bags in any areas other than the standard beds 17 and 20 on UEN and OB.

When the NPS photos are enlarged as much as possible, unambiguous oyster bags are not seen in any areas outside the standard beds at the west end of the lateral channel. The pixels are often bigger than seals and oyster bags. In some of the NPS photos, a few

lines of oyster bags can be seen, and they are always in the normal beds #17 (UEN) and #20 (OB). The other smaller polygons occasionally contain some dark dots, but dots are seen all over the aerial photographs of the sandbars, and there is no reason to believe that these dots represent oyster bags. After all, seals are bigger than oyster bags, and they cannot be seen in most of these photos.

During the course of the MMC review process over the summer 2011, Becker provided two different NPS 2008 maps of oyster bags (compare pages 26 to 27). In the map on page 27, the oyster bag areas on UEN away from bed #17 are fewer and smaller than in the map on page 26. What data were used to draw the original map? What data were used to change the map? If the NPS aerial photo data on oyster bags is clear, why did the maps change? Who made the change? Why was it made?

In summary, although we have repeatedly asked for all data supporting the NPS claims that DBOC has oyster bags along the south and east ends of UEN near the harbor seal haul-out sites, NPS failed to provide any data sufficient to support NPS claims in the published paper. The aerial photographs show no oyster bags in those areas identified by NPS in Figure 1 of Becker 2011 as having oyster bags.

The 281,000 photographs from the NPS secret cameras (2007 to 2010) show oyster boats at the west end of the lateral channel, and oyster workers tendings beds #17 on UEN and #20 on OB at the west end of the sandbars (page 29). None of the photographs show oyster boats or workers anywhere near the eastern end of UEN where NPS maps claim that oyster bags were located in 2007 and 2008. Why would the oyster workers park their boats in the normal location, and given large expanses of available sandbar in front of them, drag oyster bags for 500-600 yards across the sandbars to some of these so-called oyster bag locations as drawn on the NPS maps? This makes no sense. NPS has provided no data to back up their maps and claims.

We obtained aerial photographs for 2008, 2009, and 2010 from CDFG (pages 30-32). The same CDFG photographs were subsequently provided by Becker during the MMC review process in summer 2011. Oyster bags are difficult to resolve in any of these aerial photographs, but the CDFG photos are better than the NPS photos. In the CDFG photos, white lines of oyster bags can be seen in their normal locations in bed #17 on UEN and bed #20 on OB. No white lines or oyster bags are seen on UEN in any of the CDFG photos, including 2008. This contradicts the NPS maps of oyster bags.

Finally, on April 26, 2011, Todd Pickering and John Hulls took higher-resolution aerial photographs from a helicopter flying over Drakes Estero. Their photos (an example of which is shown on page 33) show oyster bags (bag culture) at the normal locations along the west end of UEN and OB, and in addition more distinct rows of oyster clusters (cluster culture) at the far west end of OB.

In summary, NPS has provided no data showing oyster bags on UEN and OB anywhere other than their normal locations. The normal location of the oyster beds are consistent with all of the aerial photos in which oyster bags are visible, and the location of the oyster boats in the photos from the NPS secret cameras. The NPS claims and maps of oyster bags in pupping areas are incorrect.

Conclusion 4: Claims of zero oyster bags at OB/UEN from 2000-2004 are incorrect; CDPH records show JOC continued to harvest from UEN & OB

Based upon the inferences shown in Table A1 and used in Figure 4 of Becker 2011, the

NPS scientists claim that Johnson's Oyster Company had no oyster activity at UEN and OB during 2000-2004 (page 35). What is the basis for Becker's claim? We asked for all data (i.e., photographs and notebooks) supporting this claim.

On table A1 in the appendix to Becker 2011, the NPS scientists provide the "*source(s) of inference*" from which they derived the "*inferred level of mariculture use of sandbars near seals*" that drove the categorical designation OYST Hi/Low.

Becker 2009 was criticized by the NAS (May 5, 2009) for using annual oyster harvest as a proxy for oyster activity at UEN/OB during pupping season (March-May). Becker 2011 used a series of 'inferences' to claim that they could infer oyster activity at UEN/OB during pupping season. This was used to drive OYST Hi/Low model. However, the inferences were incorrect.

Significantly, the NPS scientists claimed that JOC had zero oyster activity at UEN/OB during pupping season in 2000-2004. The inferences driving these conclusions came from: annual oyster harvest, aerial photos, and personal observations (page 38). As described above, annual oyster harvest is irrelevant to UEN/OB during pupping season. The NPS scientists misinterpreted the photos, seeing oyster bags where they were not and not seeing oyster bags where they were (see below). The personal observations of David Press were flawed. Without notebooks, either his memory was incorrect or he never really visited the right area.

The NPS scientists failed to obtain the key data from CDPH, CDFG, JOC, and DBOC that conclusively shows oyster activity (cluster culture and bag culture) at UEN and OB during 2000-2004.

Over the past several decades, JOC and DBOC have used three diffrerent types of oyster culture at UEN and OB (page 39).

(1) **Stick culture**: sticks protruding from sand by several feet with hanging clusters; very visible in 1993 & 1994 photos; used by JOC; phased out in mid to late '90's (shown in 1993 photo on page 39).

(2) **Cluster culture**: cluster of oysters not in bags but lying on sandbar; just visible in 2003-2005 photos on OB; largely replaced by bags and used sparingly today (shown in 2004 photo on page 29).

(3) **Bag culture**: oysters in bags on sandbar; least visible in aerial photos (only with high resolution and right light angle); prevalent but not seen in earlier photos (shown on 2009 photo on page 29).

Becker 2011 claimed that oysters were present at OB but not UEN in 2005. This is shown by the green polygon in the NPS map on page 40. But Becker 2011 was incorrect. They could see the cluster cultures on OB in their 2005 photo, but they could not see the bag cultures (i.e., oyster bags) on UEN. Yet CDPH and DBOC records clearly show that DBOC workers were harvesting oyster bags on UEN in 2005. The oyster bags were invisible in the aerial photos in 2005, just as they were invisible in the photos in 2003 and 2004.

The cluster cultures can be seen on OB in the NPS 2005 photo, but the oyster bags can not be seen at this resolution on UEN (page 41). Similarly, the cluster cultures can be seen on OB in the CDFG 2004 photo, but the oyster bags can not be seen at this resolution on UEN (page 42). The same is the case for 2003. The cluster cultures can be seen on OB in the CDFG 2003 photo, but not the oyster bags on UEN (page 43).

Becker 2011 incorrectly claimed that oysters were at OB in 2005 but not 2003 and 2004.

Oyster clusters were at the same location on OB in all three years. Becker 2011 incorrectly claimed that oysters were not at UEN in 2005 and the five previous years. But CDPH, JOC, and DBOC records show that JOC and DBOC continually harvested oyster bags from bed #17 on UEN during all of those years.

In conclusion, the photographic data contradicts Becker 2011 (page 44):

(1) Cluster cultures on OB are seen in CDFG photos for 2003, 2004, and 2005.

(2) Cluster cultures on OB are nearly identical for 2003, 2004, and 2005.

(3) Oyster bags on UEN are NOT seen in 2005 photos when we know oyster bags were present on UEN, just as they are not seen in 2003 and 2004 photos.

(4) Yet CDPH, JOC, and DBOC records (see below) indicate that bag cultures were present on UEN and nearly identical in 2003, 2004, and 2005.

(5) The NPS scientists misinterpreted the photographic data and got it wrong.

David Press personal observations and 2003 photos. Becker 2011 relied on the personal observations of David Press and his 2003 photos (taken sometime between April 18 and May 19, 2003; page 45) while he was a UC Davis masters student working at Barries Bay and commuting out into the Estero by canoe. The David Press photos are at the wrong location and wrong angle to see the oyster bags. This is confirmed by nearly identical photos taken by Kevin Lunny from the same location on January 1, 2009. In Lunny's photos (page 46) no bags are visible, and yet we know, and NPS confirms in their maps, that DBOC had a large number of oyster bags at bed #17 on UEN and #20 on OB in 2009. Thus, from the vantage point and height of the Press and Lunny photos, the oyster bags are not visible. NPS and CDFG aerial photos show large numbers of oyster bags in 2009 when Kevin Lunny took his photo, but they are not seen in these photos. Thus the David Press photographic data do not support the NPS claims and are contradicted, as shown below, by CDPH records, JOC employee statements, and aerial photographs.

Statements from former JOC owner, manager, and foreman. We obtained statements three key people, all claiming that JOC continued to harvest oysters from bed #17 (UEN), bed #20 (OB), and other neighboring beds throughout 2000-2004, even as overall oyster production decreased (page 48). The reason was simple: bed #17 is the only place where JOC or DBOC can harvest after rainfall, and thus is key for maintaining oyster harvest in months such as March and into April (it is the only place in California where CDPH permits harvesting after rainfall). These former JOC employees are:

(1) Jorge Mata, former JOC foreman and current DBOC foreman,

(2) Nellie Gamez, former JOC office manager who collected all records, and

(3) Mark Johnson, former JOC co-owner.

California Department of Public Health records. CDPH keeps records of oyster harvest after rainfall. The oyster farm is only allowed to harvest from bed #17 (UEN) after rainfall. CDPH officials provided us with several records from their files (pages 49 and 50) showing oyster harvest from bed #17 in December 2001 (page 49), January 2003 (page 50), and April 2003 (page 50). This conclusive evidence confirms the statements from the former JOC employees that they continued to harvest from UEN and OB throughout 2000-2004.

In conclusion, Becker 2011 claimed there were no oysters harvested at OB & UEN in last five JOC years (2000-2004), and that DBOC increased activity in 2005. This was

incorrect. In January 2005, DBOC inherited cluster cultures on OB and oyster bags on UEN from JOC. DBOC planted new oyster seed in Home Bay. These oysters did not get big enough to transfer to oyster bags on UEN and OB until late 2006.

The inferences and claims in Becker 2011 concerning the lack of oyster activity on UEN and OB from 2000-2004 is contradicted by CDPH records; JOC and DBOC employees, managers, and owners; and the CDFG aerial photographs.

The 2003, 2004, & 2005 photos share two things in common. First, just visible are similar oyster clusters (cluster culture) on OB (bed #20). Second, not visible are the equally similar oyster bags (bag culture) on UEN (bed #17). Had Becker worked with Lunny, as MMC suggested, he would have learned this and would not have made the incorrect inference on Table 1A, would not have put the incorrect data on Figure 4, and would not have devised the incorrect categorical designation OYST Hi/Low.

Conclusion 5: Inferences that drove OYST Hi/Low categorical model are incorrect; NPS did not provide conclusive data to support major model in paper

In summary, Becker 2011 claimed that in final 5 JOC years (2000-2004), there were no oyster bags and no oyster activity at UEN/OB. This is incorrect. CDPH records show continued harvest from bed #17 (UEN) and aerial photos show continued oyster clusters at bed #20 (OB).

Becker 2011 used incorrect data and made inaccurate and misleading claims in Figures 1 & 4 (page 55). Figure 1 contains a misleading seal haul-out map and a misleading oyster bag map. Figure 4 used incorrect 2000-2004 oyster bag data, incorrect 2005 and 2007 data, and misleading 1993 and 1994 data (based upon the former stick culture system).

Becker 2011 used incorrect inferences and misinterpreted photographs in Table 1A (page 56). Table 1A contains incorrect inferences, misrepresented photos, and misuse of harvest data.

Becker 2011, based upon incorrect inferences, used OYST Hi/Low as inappropriate surrogate for UEN/OB. This was the major model used to drive the statistical analysis in Becker 2011. In part 1 we showed that the OYST Hi/Low is a weak model that is driven by the rogue elephant seal in 2003, and is driven by 2003 and 2004 (without 2003 and 2004, it is not significant). Nevertheless, the OYST Hi/Low model was also based upon incorrect inferences and assumptions.

Vigilance vs. habituation

In the introduction to Becker 2011, the authors wrote:

> *"Thus, seals are expected to move away from, or remain vigilant to, disturbance sources rather than habituate as some smaller, quickly reproducing species do (Bisson et al., 2009)."*

The assertion that harbor seals remain vigilant rather than habituate to disturbance sources is a key tenet upon which the NPS study is based. This assertion is contradicted by Dr. Allen's study on the Castro Rocks harbor seal haul-out site in San Francisco Bay in relationship to the Richmond Bridge retrofit seismic construction in 2001 to 2005. Although Becker 2011 cited 50 references, nine of them co-authored by Dr. Allen, the Richmond Bridge study was not cited.

In a January 2006 final report entitled "*Monitoring the potential impact of the seismic retrofit construction activities at the Richmond San Rafael Bridge on Harbor seals: May 1, 1998 – September 15, 2005*" to the California Department of Transportation, Dr. Allen and colleagues reported on the impact of construction equipment within ~ 20 yards of Castro Rocks, a major San Francisco Bay harbor seal haul-out. Dr. Allen and colleagues noted that the population of seals increased during the seismic retrofit period at Castro Rocks subsite A, the site closest to the construction project. They wrote:

> *"Construction-related disturbances at Castro Rocks were attributed to two main factors; watercraft in the area of the haul-out site and construction activities such as jackhammering, rivet work, hammering and the movement of cranes on barges near the haul-out site."*
>
> *"During pupping season, subsite A at Castro Rocks remains preferred by females with pups, regardless of year (including construction years) ..."*
>
> *"During the four "work periods" of the construction … the total number of seals hauling out on Castro Rocks did not decrease …"*

The Richmond Bridge study supports the conclusion that harbor seals can habituate rather than remain vigilant to certain disturbance sources. The authors of Becker 2011 failed to comment on why they believe the harbor seals in Drakes Estero remain vigilant to oyster boats and workers at a distance of ~ 750 yards, whereas in nearby San Francisco Bay, harbor seals habituated to construction activities at ~ 20 yards.

281,000 NPS photographs reveal no oyster farm disturbances

The NPS, in a program led by Dr. Sarah Allen, collected 281,000 digital photographs on seals and oyster boats and workers from May 5, 2007 until the program ended in early June 2010. The NPS secret cameras took pictures every minute from dawn to dusk during pupping season. The majority of photos are from a camera pointing down the lateral channel from across the east shore of the main channel and thus these photos capture both the seals hauled out at OB along the east end of the lateral channel and the oyster boats and workers at the west end of the channel (page 20).

Detailed NPS logs of the 2008 and 2009 pupping season photos document no bona fide oyster farm disturbances of the OB harbor seals. The NPS logs describe 37 days in 2008 and nine days in 2009 during pupping season when DBOC boats came and went from sandbars OB and UEN. The NPS logs describe many additional days of DBOC boat trips to these sandbars in months following the pupping season (i.e., June and July). The NPS logs describe not one single bona fide disturbance during those 46 boat trips to sandbars OB and UEN during pupping season, and many more in the following months. There are no DBOC disturbances recorded. The DBOC boats stayed over 500 yards from the seals at the OB haul-out (often 600-800 yards away). The NPS-NOAA-CDFG 1992 protocols recommend a 100-yard buffer from the harbor seals.

In contrast, the NPS logs describe six instances (one in 2008 and five in 2009) in which kayakers (banned from being on the estero during pupping season) got within the recommended 100-yard buffer of the OB seals and caused 50-100% of the seals to flush into the water. The cameras caught multiple disturbances by kayakers, but none by DBOC oyster boats and workers.

Analysis of Becker et al. 2011: concluding comments

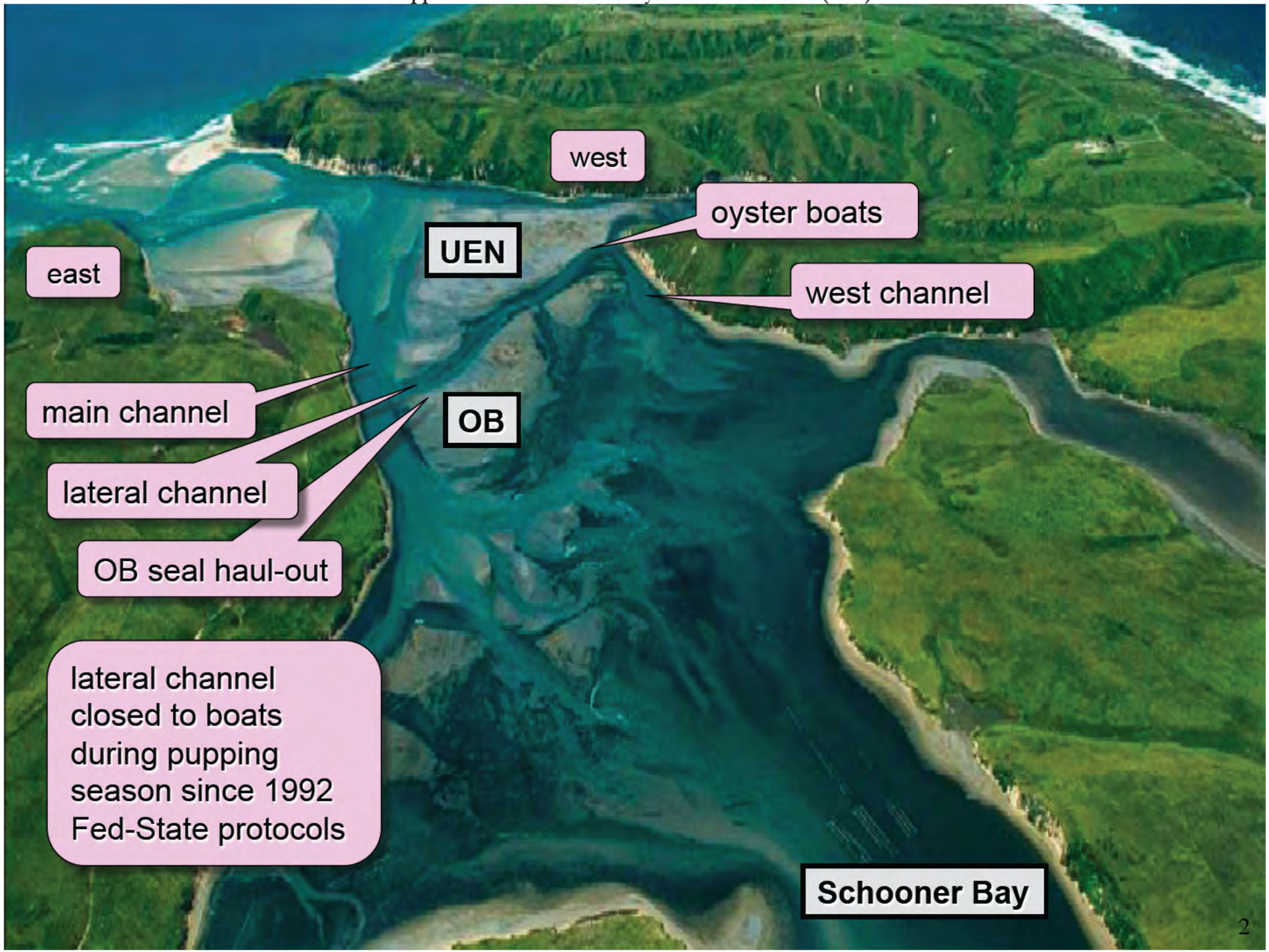
The MMC-directed review leads to a single, overriding conclusion: upon review, every aspect of NPS Becker 2011 collapses -- scientifically and statistically. The paper's title misrepresents the data: the statistical analysis reveals there is no evidence the oyster farm has caused a long-term spatial displacement of harbor seals out of Drakes Estero.

The review leads to seven major observations and conclusions:

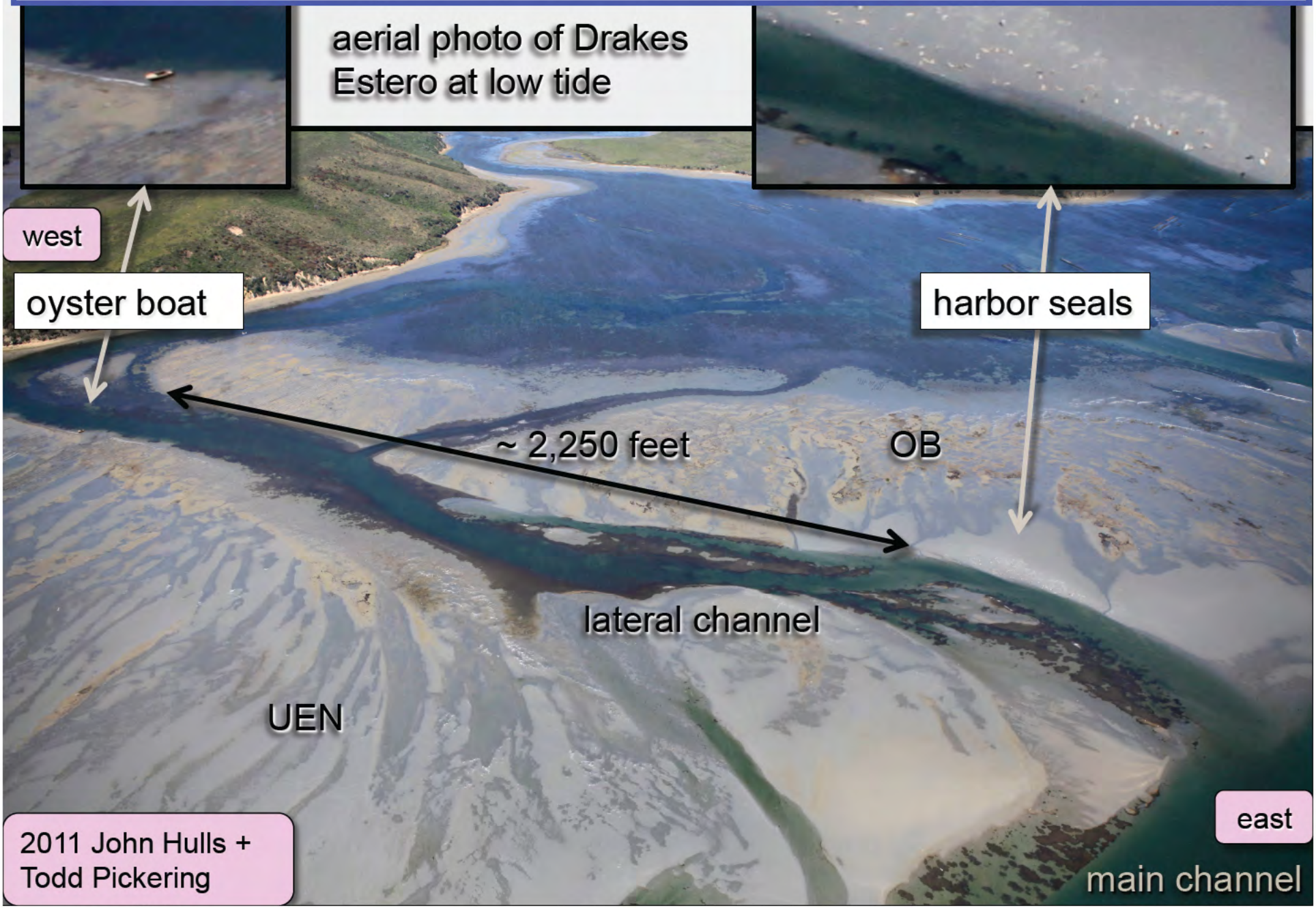
1. **Title says "*long-term spatial displacement*" but analysis shows transient; authors failed to note their statistics were driven by 2003 & 2004**
2. **Title says "*evidence*" oyster farm displaced seals but models fail; NPS data generates models 1000 times more significant than oyster activity**
3. **Title says "*three decades*" of data but 14 year gap; authors cherry picked 1982 & 1983 data; NPS previously denied these data existed**
4. **Analysis shows regional harbor seal population, events at Double Point, and elephant seals drive movements of harbor seals into Estero**
5. **Authors used incorrect seal haul-out maps, incorrect oyster bag maps, and misinterpreted aerial photos; NPS scientists never asked for DBOC data**
6. **Authors missed opportunity to determine if adaptive management succeeded with 1992 (oyster boats) & 1996 (kayak) management changes**
7. **Authors missed opportunity to use data to study biology of harbor seals and population dynamics; NPS scientists were too focused on the oyster farm**

Analysis of Becker, Press, and Allen 2011
Part 1: Statistics and Models

Corey S. Goodman, PhD


west
oyster boats
UEN
east
west channel
main channel
OB
lateral channel
OB seal haul-out
lateral channel closed to boats during pupping season since 1992 Fed-State protocols
Schooner Bay
2

Location of oyster boats relative to harbor seals at OB



Becker et al. 2011

Evidence for long-term spatial displacement of breeding and pupping harbour seals by shellfish aquaculture over three decades†

BENJAMIN H. BECKER*, DAVID T. PRESS and SARAH G. ALLEN

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ABSTRACT

1. Shellfish mariculture is increasing worldwide and often occurs adjacent to marine mammal breeding and feeding habitat. To better understand breeding pinniped vulnerability to potential shellfish mariculture disturbance and displacement effects in a US National Park, potential mechanisms were explored that may affect the proportion of harbour seals (*Phoca vitulina*) selecting high quality haul-out sites near shellfish aquaculture within a large colony, and overall seal utilization of that colony in relation to other regional colonies.

2. Seal haul-out sites isolated from the mainland (no predator access) had higher pup:adult ratios, indicating they are generally more important for pupping. Short-term human disturbance did not have a significant effect on spatial use, but rather spatial use was pre-determined by general sandbar isolation. Using multiple competing hypothesis and an information-theoretic approach, it was found that within the estuary, after removing effects of El Niño, the proportion of seals (total seals and pups only) hauled out near mariculture sites was 8 ± 2% lower during years of higher oyster harvest. Annual oyster harvest was used as a measure of aquaculture activity that could result in direct disturbance or indirect displacement of harbour seals.

3. At the regional scale, oyster harvest, seal counts at a nearby colony, and loss of a major haul-out site within the estuary, best explained pup and total seal use compared with the region. Regional population size, short-term human disturbance rate, and other factors were not important. Concurrent with higher oyster harvest, the proportion of regional seals using the estuary declined by 7 ± 2% for seal pups (−65 ± 18 total pups), and 5 ± 2% for total counts (−192 ± 58 total seals). These findings (both within the estuary and at the regional scale) were essentially identical whether modelling oyster harvest as either a continuous or categorical (low/high) variable and when using either frequentist or Bayesian statistical analyses.

4. Marine reserves set aside for wildlife may be less effective when the highest quality breeding and pupping sites are adjacent to regular aquaculture activities. These effects may not be detectable until additional natural variation lowers the quality of nearby habitats.

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KEY WORDS: *Phoca vitulina*; aquaculture; disturbance; harbour seal; generalized estimating equations; Bayesian analysis; marine protected area

INTRODUCTION

A variety of factors may influence habitat availability for breeding, moulting, and resting pinnipeds, including coastal development (Stewart and Primavilli, 2005), human encroachment and disturbance (Yochem *et al.*, 1987; Gerodette and Gilmartin, 1990; Suryan and Harvey, 1999; Thompson *et al.*, 2001), predation (Nordstrom, 2002), climate change (Freitas *et al.*, 2008), and natural variation in habitat suitability. Moreover, since longer lived, slowly reproducing K-selected species maximize their long-term survival, they tend to respond to human disturbances by increasing heart rates and energetic costs (Bisson *et al.*, 2009). Thus, seals are expected to move away from, or remain vigilant to, disturbance sources rather than habituate as some smaller, quickly reproducing species do (Bisson *et al.*, 2009). This might be particularly evident for females with pups, which should be more risk averse than adult males. Furthermore, Frid and Dill (2002) found that chronic, long-term disturbance stimuli resulted in habitat shifts and subsequently reduced access to resources in all of the 14

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This analysis relied entirely on NPS data provided by Becker

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A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
year	adult.de	adultnot.de	pup.de	pupnot.de	tot.de	totnot.de	oyst	a.max	prop.a.de	prop.a.pr	a.avail	bags.6	bags.5	tot.dp	pup.dp	prop.dp	dp.change	dist.rate	mam.dist.rat	weight	enso	92 protocol
1982	556	1674	170	492	726	2166	360004	275	0.379	0.095	1	1	1	851	263	0.294	0	0.33	1.2	1	5	0
1983	534	1678	122	444	656	2122	440139	379	0.578	0.136	1	1	1	832	262	0.299	-0.02	0.62	1.79	1	0	0
1997	854	1431	257	726	1111	2157	476791	252	0.227	0.077	1	1	1	854	357	0.261	0	0.96	1	0.3	4	1
1998	591	1362	162	366	753	1728	292188	247	0.328	0.1	1	1	1	708	187	0.285	-0.17	0.93	0.85	1	0	1
1999	637	1620	285	783	922	2403	125749	241	0.261	0.072	1	0	1	890	335	0.268	0.26	0.77	0.61	1	1	1
2000	755	1778	376	962	1131	2740	34094	325	0.287	0.084	1	0	0	1076	412	0.278	0.21	0.49	0.55	1	2	1
2001	687	1827	327	902	1014	2729	65676	309	0.305	0.083	1	0	0	913	350	0.244	-0.15	0.49	0.39	1	3	1
2002	904	2231	377	813	1281	3044	78064	297	0.232	0.069	1	0	0	1162	380	0.269	0.27	0.87	0.52	1	4	1
2003	1066	1916	486	746	1552	2662	118643	315	0.203	0.075	1	0	0	459	105	0.109	-0.6	0.74	0.75	1	5	1
2004	1183	2322	461	803	1644	3125	96754	313	0.19	0.066	1	0	0	929	264	0.195	1.02	0.42	0.33	1	6	1
2005	754	1951	332	771	1086	2722	138958	220	0.203	0.058	1	1	1	928	289	0.244	0	0.65	0.46	1	7	1
2006	784	1962	287	660	1071	2622	291538	130	0.121	0.035	0	1	1	783	245	0.212	-0.16	0.63	0.1	1	8	1
2007	759	1786	273	624	1032	2410	468000	21	0.02	0.006	0	1	1	684	215	0.199	-0.13	0.94	0.93	1	9	1
2008											0	1	1	824	328	0.236	0.2	0.76	0.75	1	10	1
2009											0	1	1	724	298	0.229	-0.12	0.36	0.43	1	11	1

ADULT

Year	Bolinas Lagoon	Double Point	Drakes Estero	Duxbury Reef	PR Headlands	Tomales Bay	Tomales Point
1982	109	588	556	109	213	227	428
1983	119	570	534	166	178	230	394
1997	161	497	854		117	389	267
1998	96	521	591		126	256	363
1999	133	555	637	88	130	435	279
2000	165	664	755	92	118	470	269
2001	224	563	687	71	65	516	388
2002	288	782	904	107	110	529	415
2003	312	354	1066	136	145	594	375
2004	239	665	1183	131	161	497	629
2005	318	639	754	93	84	504	313
2006	361	538	784	72	126	503	362
2007	262	469	759	81	119	481	374
2008	272	496	627	32	142	382	384
2009	281	426	561	59	131	438	255

PUP

Year	Bolinas Lagoon	Double Point	Drakes Estero	Duxbury Reef	PR Headlands	Tomales Bay	Tomales Point
1982	17	263	170		19	58	135
1983	17	262	122		1	45	120
1997	51	357	257		24	141	153
1998	47	187	162		24	34	74
1999	59	335	285	10	38	190	151
2000	108	412	376	20	45	188	189
2001	123	350	327	5	51	179	194
2002	123	380	377	3	31	144	132
2003	150	105	486	4	46	178	263
2004	123	264	461	15	57	202	142
2005	143	289	332	6	44	188	101
2006	149	245	287	17	41	108	100
2007	126	215	273	7	46	72	158
2008	153	328	341	3	64	118	154
2009	143	298	272	3	68	89	129

This analysis relied entirely on NPS data shown here provided by Becker. Just as in Becker 2011, columns were added together, or one divided by another to get proportions, or certain years excluded or adjusted. Regression analysis was done using NPS data as defined in this report.

Becker's best models derived from these columns

proportion pups DE = pup.de / total regional pups

total regional pups

OYST Hi/Low

year	pup.de	pupnot.de	bags.5
1982	170	492	1
1983	122	444	1
1997	257	726	1
1998	162	366	1
1999	285	783	1
2000	376	962	0
2001	327	902	0
2002	377	813	0
2003	486	746	0
2004	461	803	0
2005	332	771	1
2006	287	660	1
2007	273	624	1
2008	341	820	1
2009	272	739	1

Becker's best models all included bags.5 = OYST Hi/Low categorical designation as surrogate for oyster activity at OB/UEN during pupping season (Mar–May)

Models 1000 times more significant from these columns

Becker listed prop.dp (proportion seals DP) but not prop. pups DP = pup.dp/total reg. pups

total regional seals

seals Double Point

pups Double Point

tot.dp/total reg. seals

As shown on page 44, prop.seals.dp is better than Becker's best multi-model.

year	tot.de	totnot.de	tot.dp	pup.dp	prop.dp	92 protocol
1982	726	2166	851	263	0.294	0
1983	656	2122	832	262	0.299	0
1997	1111	2157	854	357	0.261	1
1998	753	1728	708	187	0.285	1
1999	922	2403	890	335	0.268	1
2000	1131	2740	1076	412	0.278	1
2001	1014	2729	913	350	0.244	1
2002	1281	3044	1162	380	0.269	1
2003	1552	2662	459	105	0.109	1
2004	1644	3125	929	264	0.195	1
2005	1086	2722	928	289	0.244	1
2006	1071	2622	783	245	0.212	1
2007	1032	2410	684	215	0.199	1
2008	968	2528	824	328	0.236	1
2009	833	2332	724	298	0.229	1

And some important insights from these columns

year	OYST Hi/Low (bags.5)	ann. oyster harvest (oyst)	disturbance rate (dist.rate)
1982	1	360004	0.33
1983	1	440139	0.62
1997	1	476791	0.96
1998	1	292188	0.93
1999	1	125749	0.77
2000	0	34094	0.49
2001	0	65676	0.49
2002	0	78064	0.87
2003	0	118643	0.74
2004	0	96754	0.42
2005	1	138958	0.65
2006	1	291538	0.63
2007	1	468000	0.94
2008	1	438000	0.76
2009	1	450000	0.36

Becker 2011 claimed the categorical designation OYST Hi/Low gave the same results as annual oyster harvest. Analysis later in this report shows this is not correct. Becker 2011 also did not show analysis using disturbance rate on its own. There is no relationship to seals (either considering proportion in Drakes Estero or proportion at certain subsites in the Estero) as shown in slides below. This refutes the Becker 2009 paper.

Analysis of Becker et al. 2011: conclusions part 1

Evidence for long-term spatial displacement of breeding and pupping harbour seals by shellfish aquaculture over three decades†

BENJAMIN H. BECKER*, DAVID T. PRESS and SARAH G. ALLEN
US National Park Service, Point Reyes National Seashore, Point Reyes Station, CA 94956, USA

1. Analysis reveals no "*evidence for long-term spatial displacement*"

2. No "*evidence*" that oyster farm displaced seals out of Estero

3. Mother Nature leads to movements of seals into & out of Estero
Major factors: seals at Double Point (DP) & total regional seals

4. Rogue elephant seal at DP in 2003 displaced seals into Estero
Becker 2011 best models are driven by transient spike in 2003 & 2004

5. Top models using NPS data are far superior to Becker's best model
Best P-values are 1000 times more significant than in Becker 2011

Becker et al. 2011

Evidence for long-term spatial displacement of breeding and pupping harbour seals by shellfish aquaculture over three decades†

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ABSTRACT

1. Shellfish mariculture is increasing worldwide and often occurs adjacent to marine mammal breeding and feeding habitat. To better understand breeding pinniped vulnerability to potential shellfish mariculture

2. Seal haul-out sites isolated from the mainland (no predator access) had higher pup:adult ratios, indicating they are generally more important for pupping. Short-term human disturbance did not have a significant effect on spatial use, but rather spatial use was pre-determined by general sandbar isolation. Using multiple competing hypothesis and an information-theoretic approach, it was found that within the estuary, after removing effects of El Niño, the proportion of seals (total seals and pups only) hauled out near mariculture sites was $8 \pm 2\%$ lower during years of higher oyster harvest. Annual oyster harvest was used as a measure of aquaculture activity that could result in direct disturbance or indirect displacement of harbour seals.

3. At the regional scale, oyster harvest, seal counts at a nearby colony, and loss of a major haul-out site within the estuary, best explained pup and total seal use compared with the region. Regional population size, short-term human disturbance rate, and other factors were not important. Concurrent with higher oyster harvest, the proportion of regional seals using the estuary declined by $7 \pm 2\%$ for seal pups (-65 ± 18 total pups), and $5 \pm 2\%$ for total counts (-192 ± 58 total seals). These findings (both within the estuary and at the regional scale) were essentially identical whether modelling oyster harvest as either a continuous or categorical (low/high) variable and when using either frequentist or Bayesian statistical analyses.

Gerodette and Gilmartin, 1990; Stryan and Harvey, 1999; Thompson *et al.*, 2001), predation (Nordstrom, 2002), climate change (Freitas *et al.*, 2008), and natural variation in habitat suitability. Moreover, since longer lived, slowly reproducing K-

evident for female
than adult males.
chronic, long-ter
and subsequently

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Key conclusion in Becker 2011:
7 +/- 2% spatial displacement of pups out of Estero due to "*higher oyster harvest*"

10

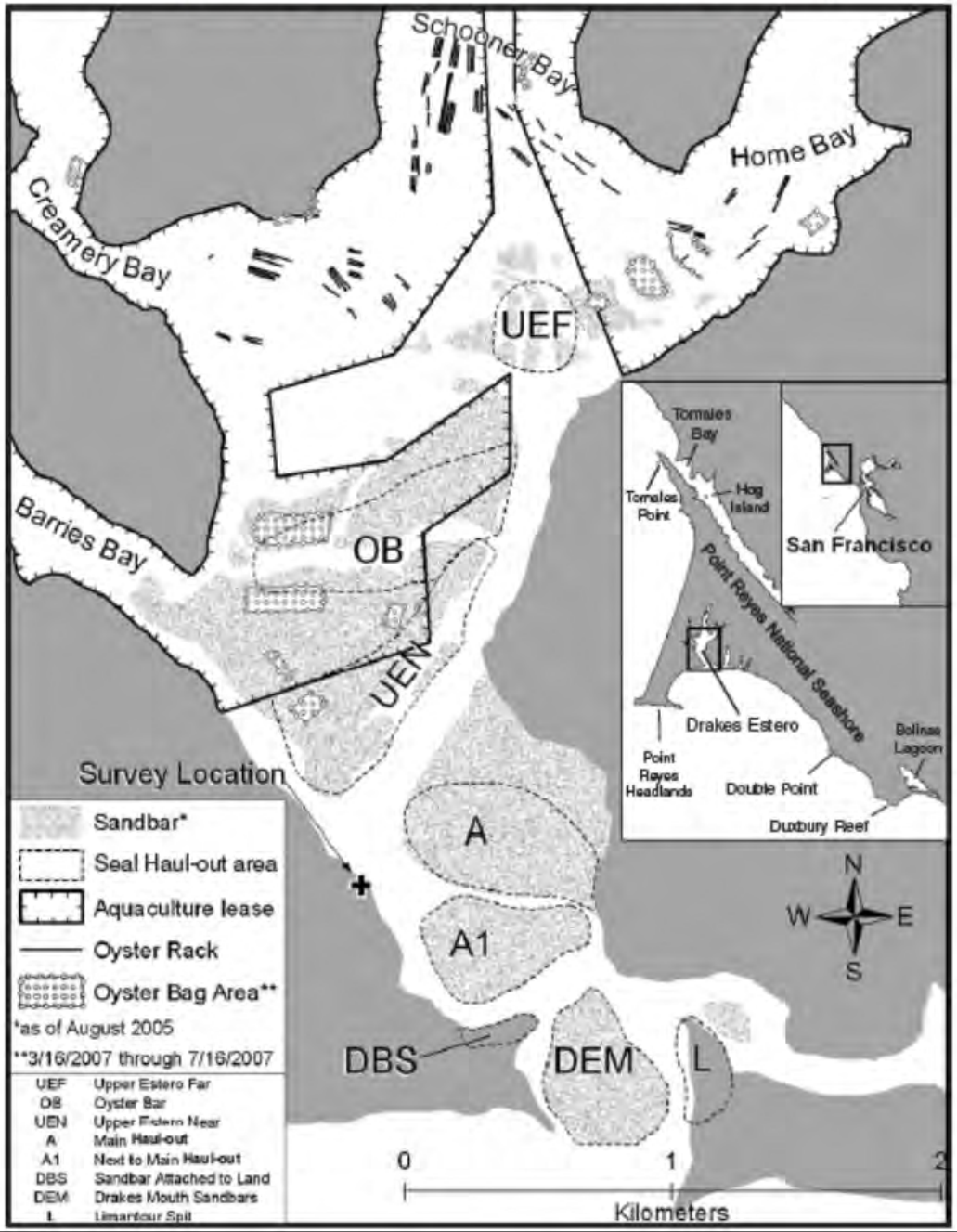
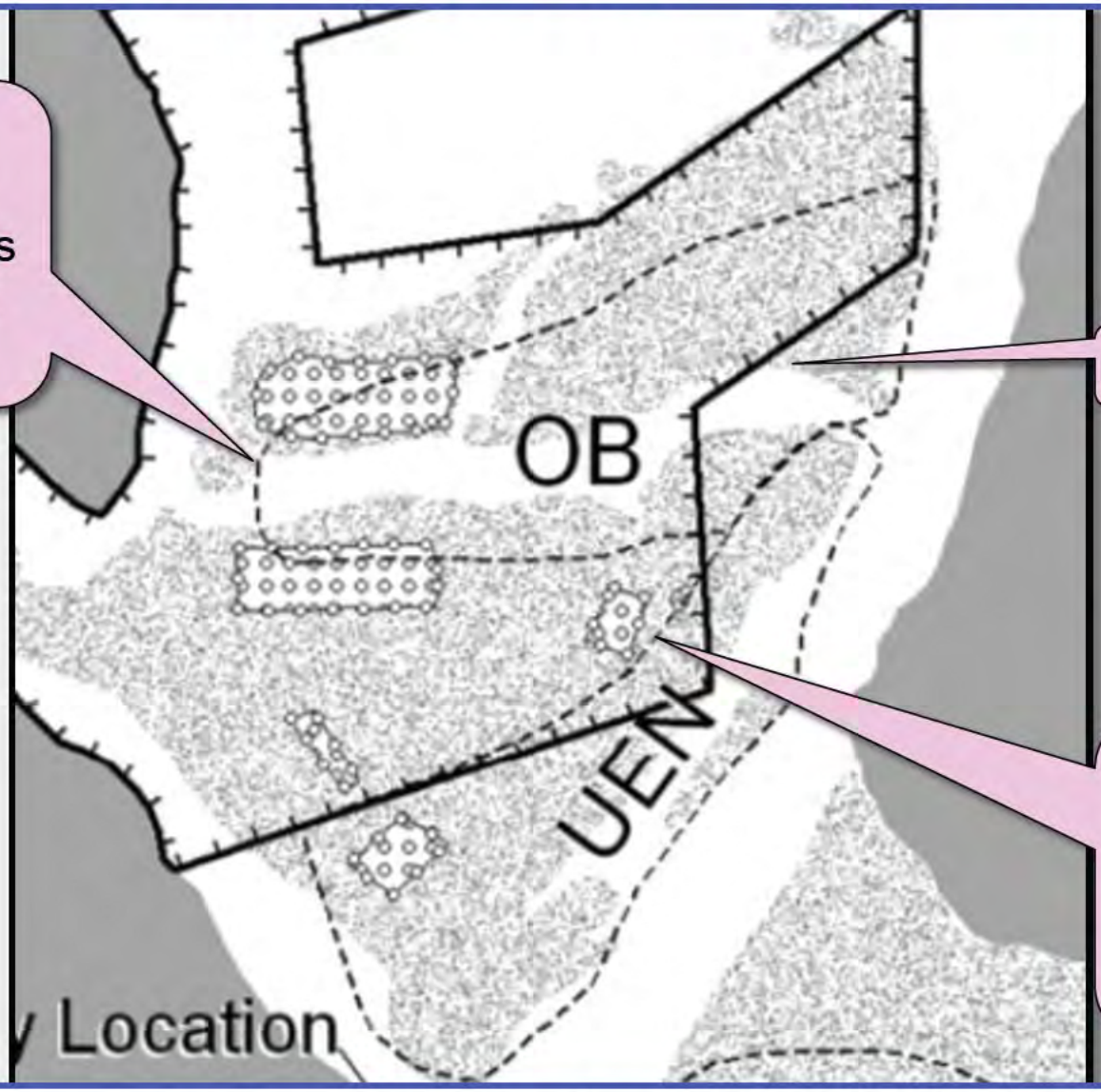


Figure 1.| Drakes Estero and the eight labelled seal haul-out subsites.

Figure 1 in Becker 2011 gives false impression that oyster bags are within seal haul-outs – map is inaccurate



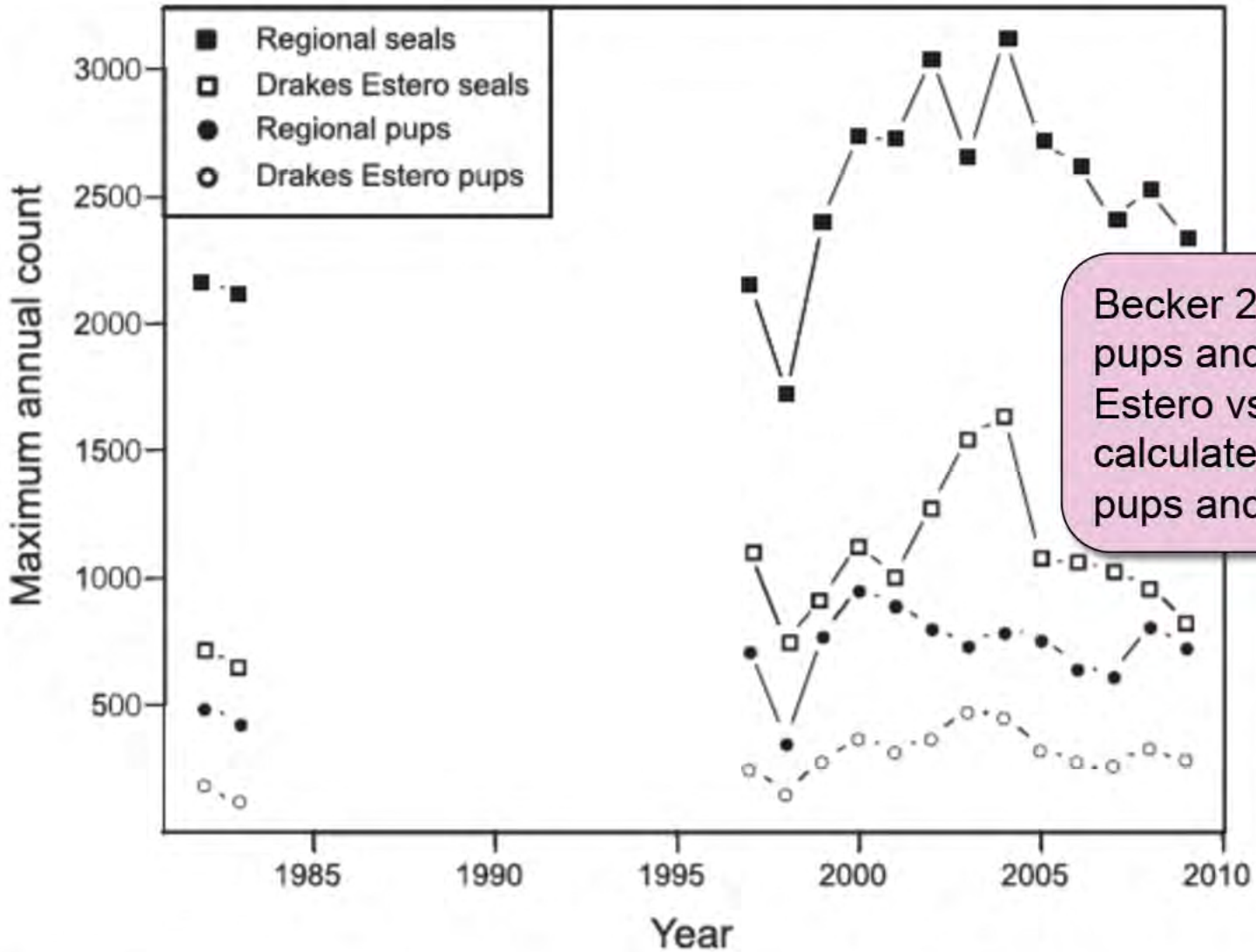
Did NPS provide data to support this seal haul-out map? A: no.

OB seals

Did NPS provide data to support this oyster bag map? A: no.

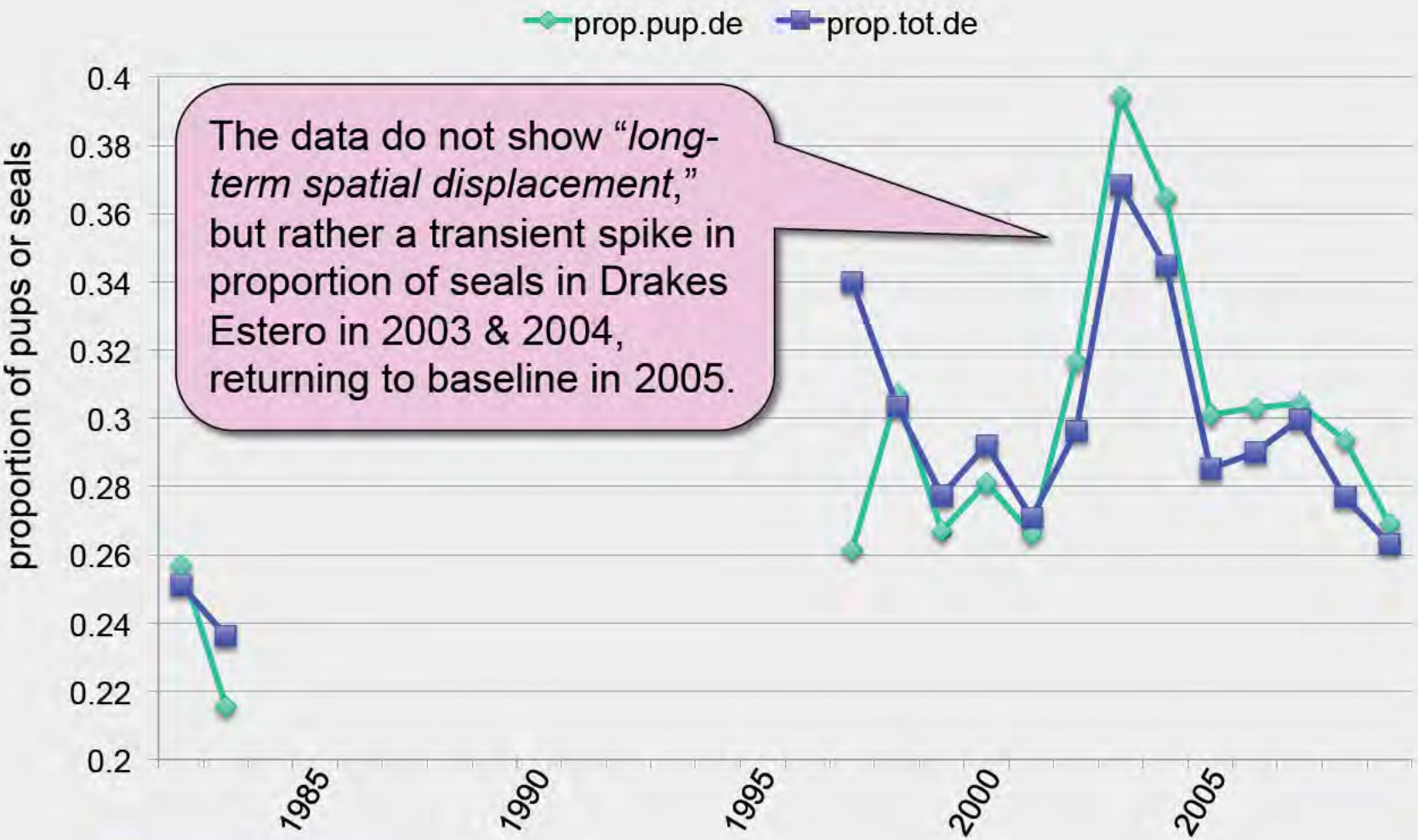
maps, haul-outs, & oyster bags discussed in part 2

2

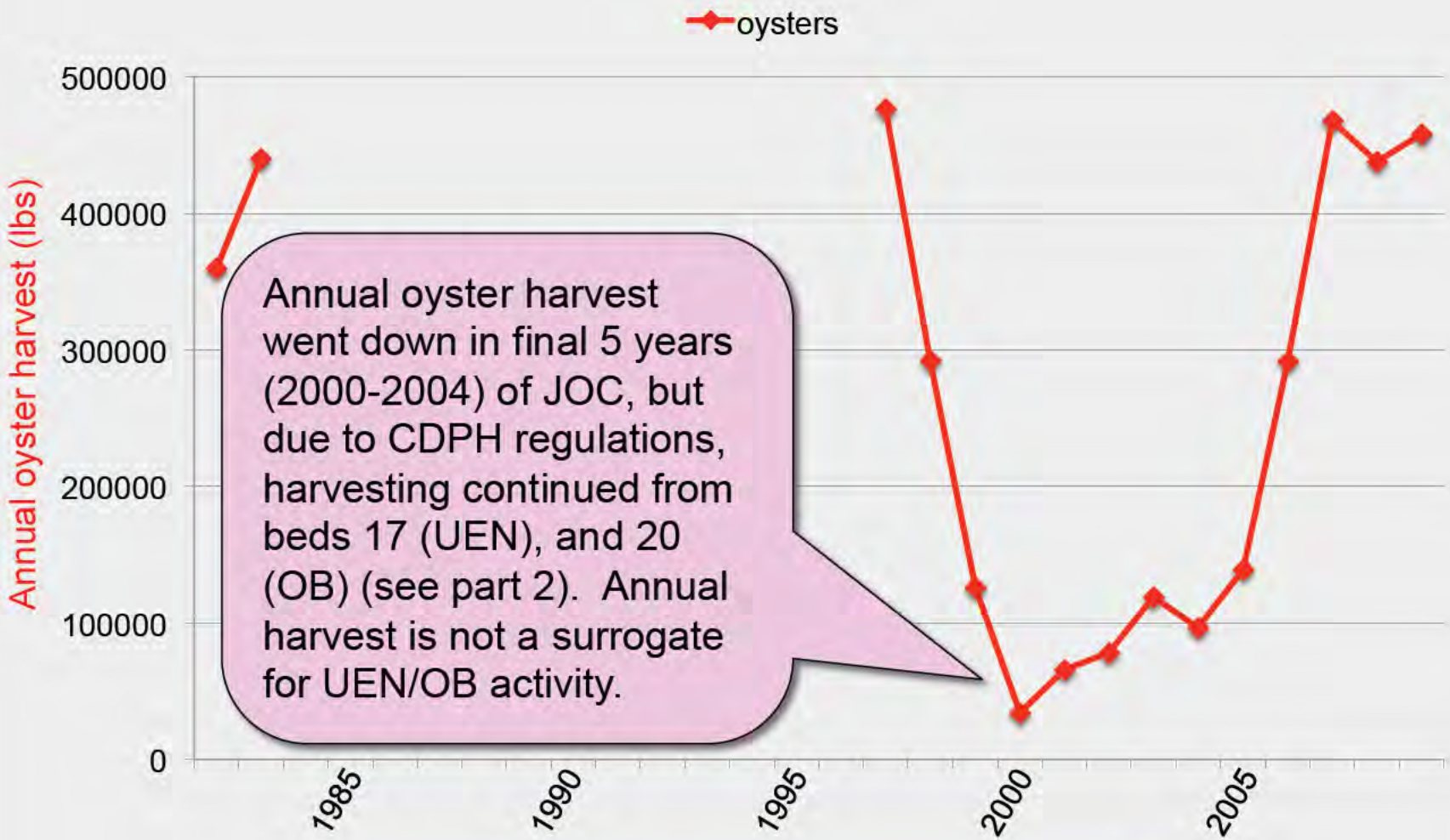


Becker 2011: compared pups and seals in Drakes Estero vs. region, and calculated proportion of pups and seals in Estero

Figure 2. Annual maximum counts of harbour seals in Drakes Estero and the Point Reyes region (less Drakes Estero) during the peak pupping period (15 April–15 May) from 1982–2009. Regional surveys were not conducted between 1984 and 1996.

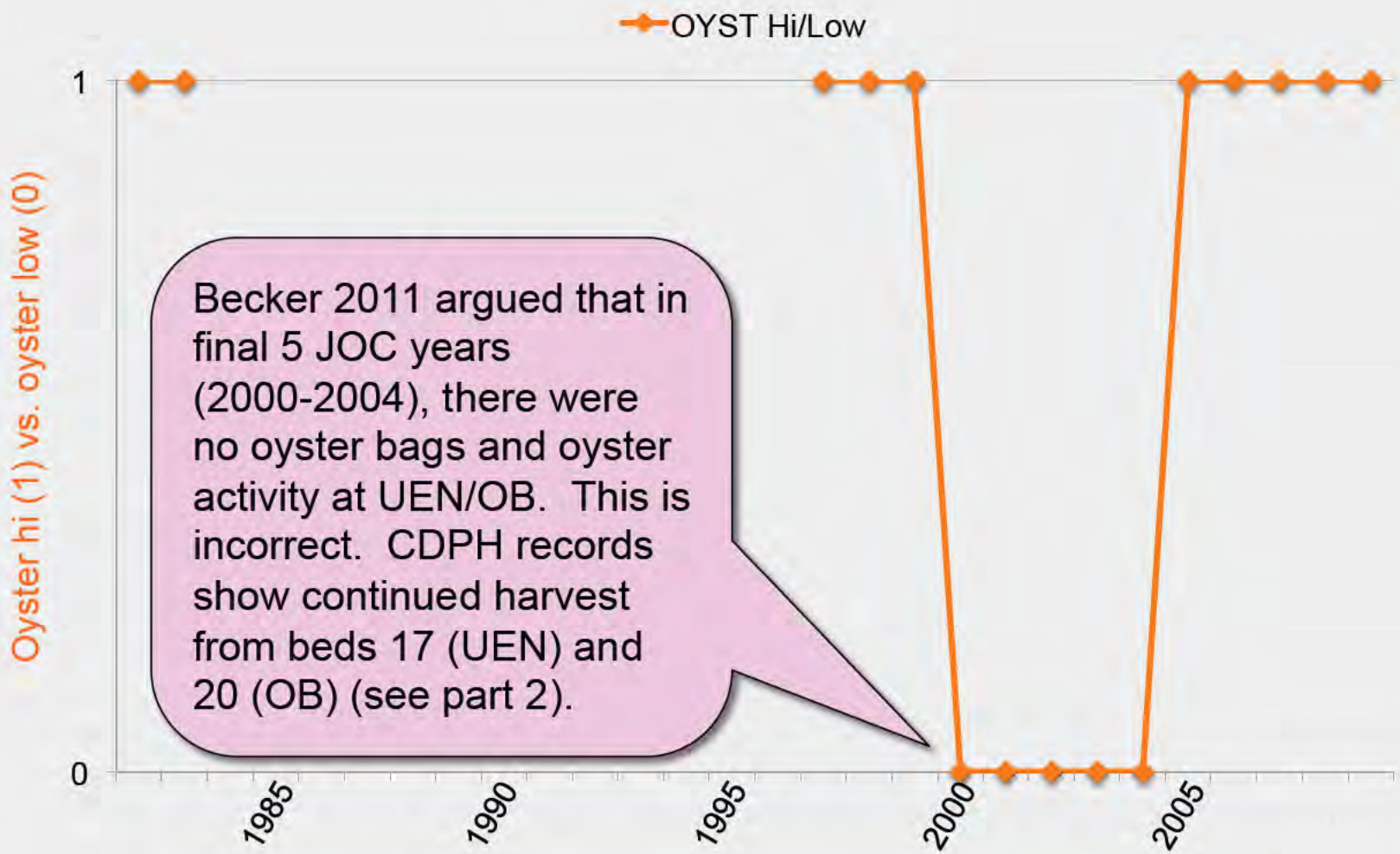


proportion of pups and seals in Drakes Estero

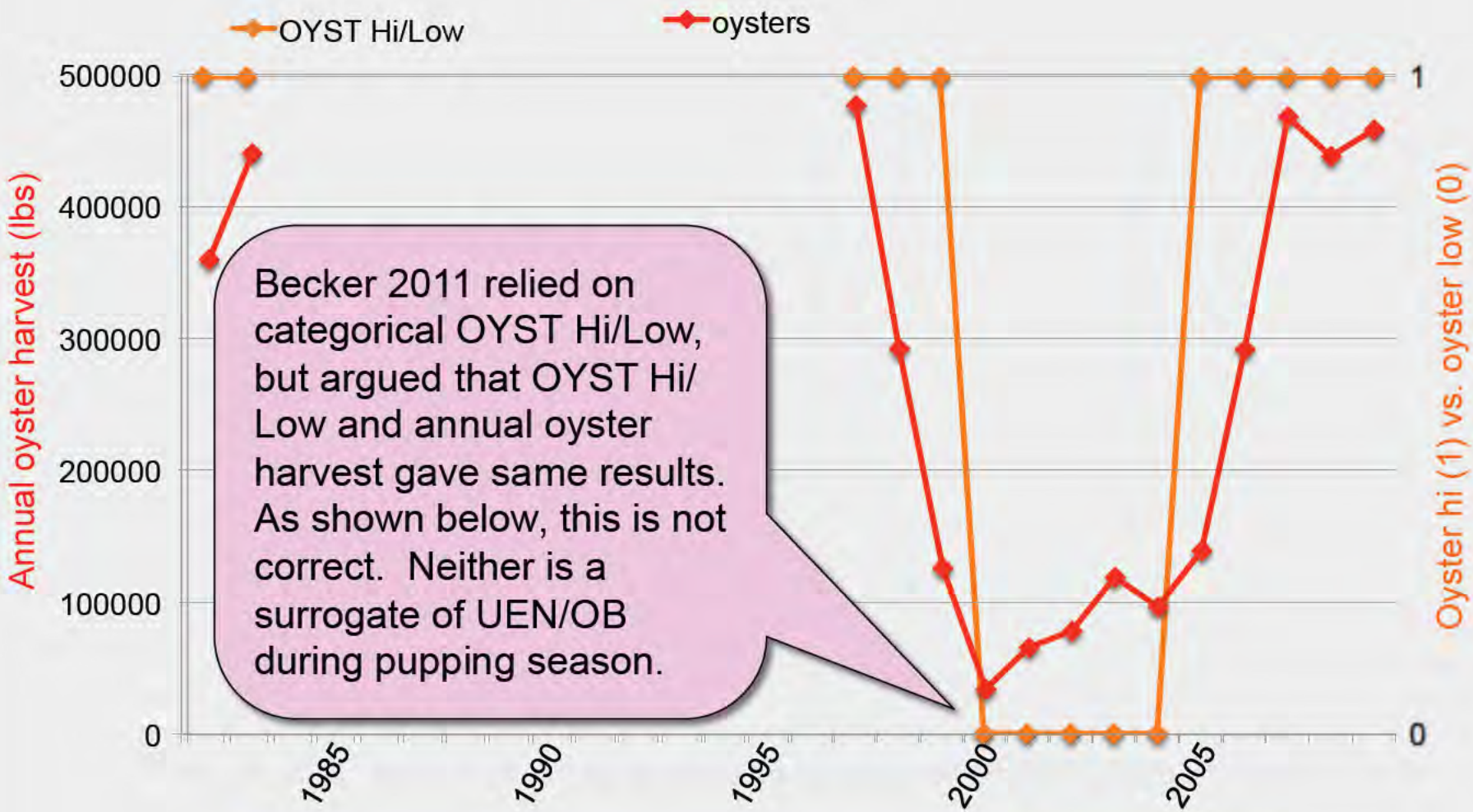


annual oyster harvest

15

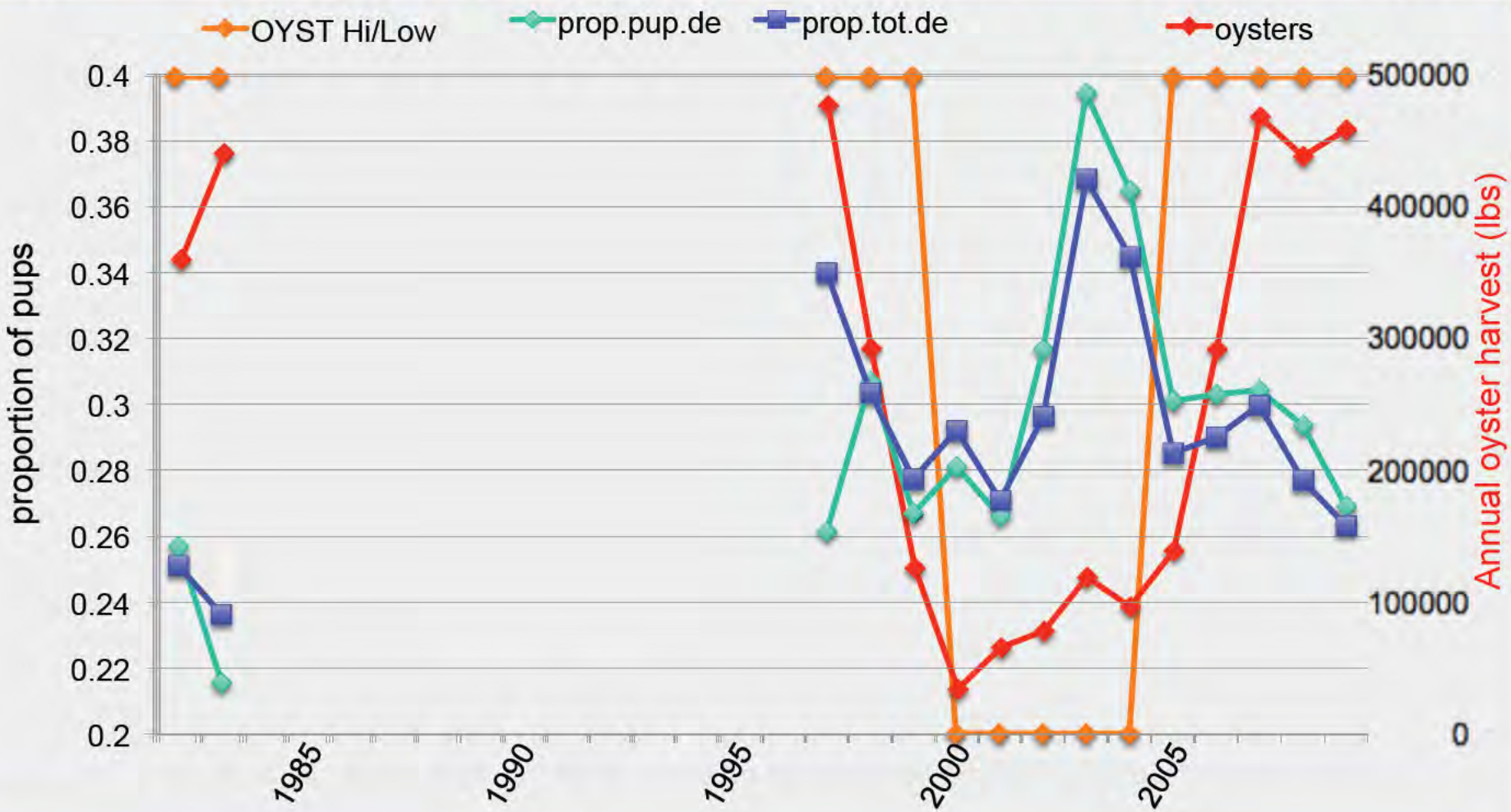


OYST Hi/Low categorical oyster activity



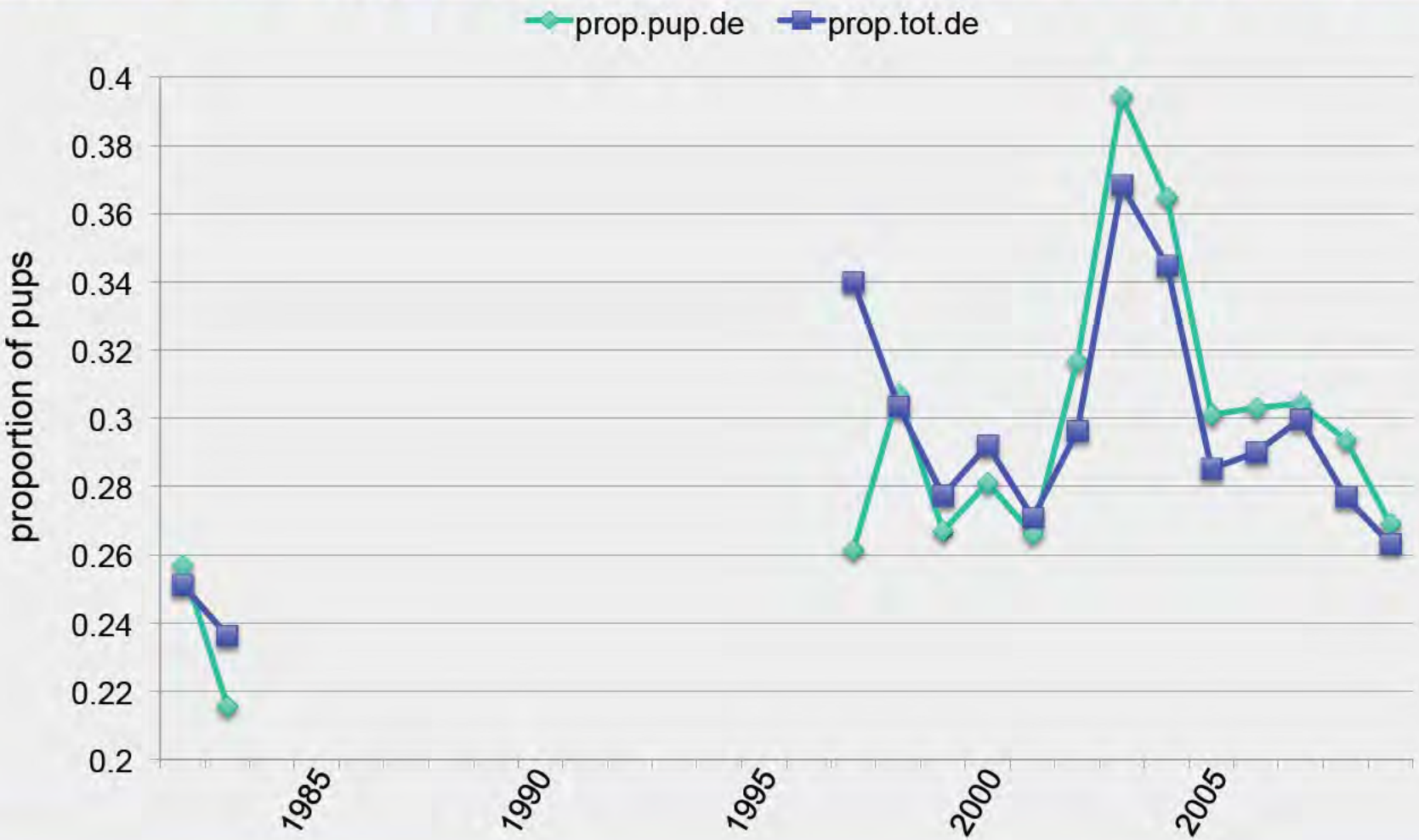
annual oyster harvest vs. OYST Hi/Low

Becker 2011 examined what variable (or variables) correlated with changes in proportion of pups or seals in Drakes Estero



Maybe the oyster farm is a good explanation …

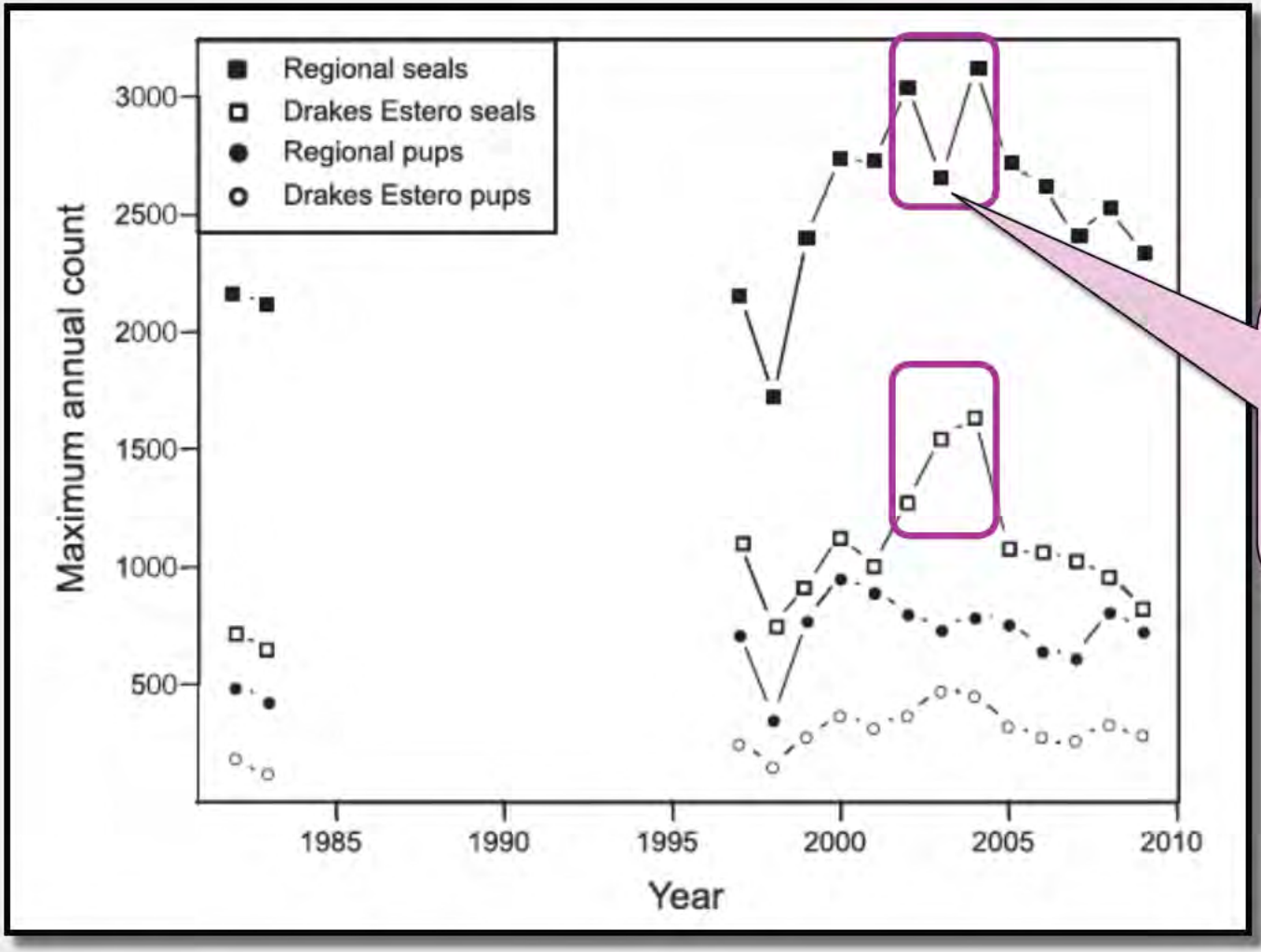
Becker 2011 examined what variable (or variables) correlated with changes in proportion of pups or seals in Drakes Estero



… but could there be a better explanation? Answer: yes.

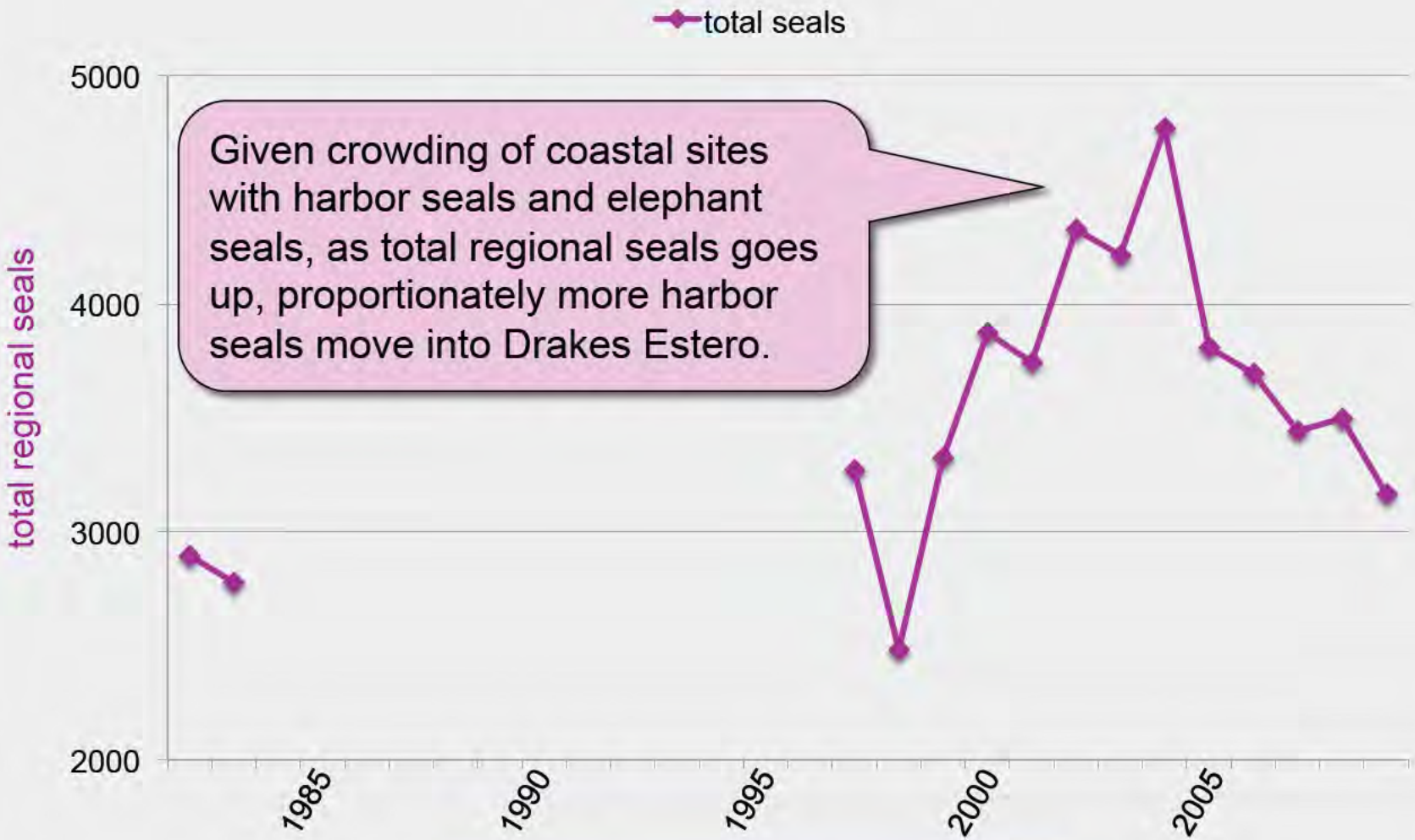
Evidence for long-term spatial displacement of breeding and pupping harbour seals by shellfish aquaculture over three decades†

BENJAMIN H. BECKER*, DAVID T. PRESS and SARAH G. ALLEN
US National Park Service, Point Reyes National Seashore, Point Reyes Station, CA 94956, USA



Increased total regional seals + one rogue elephant seal at Double Point in 2003.

20



total regional seals (DE and non DE)

21

Evidence for long-term spatial displacement of breeding and pupping harbour seals by shellfish aquaculture over three decades†

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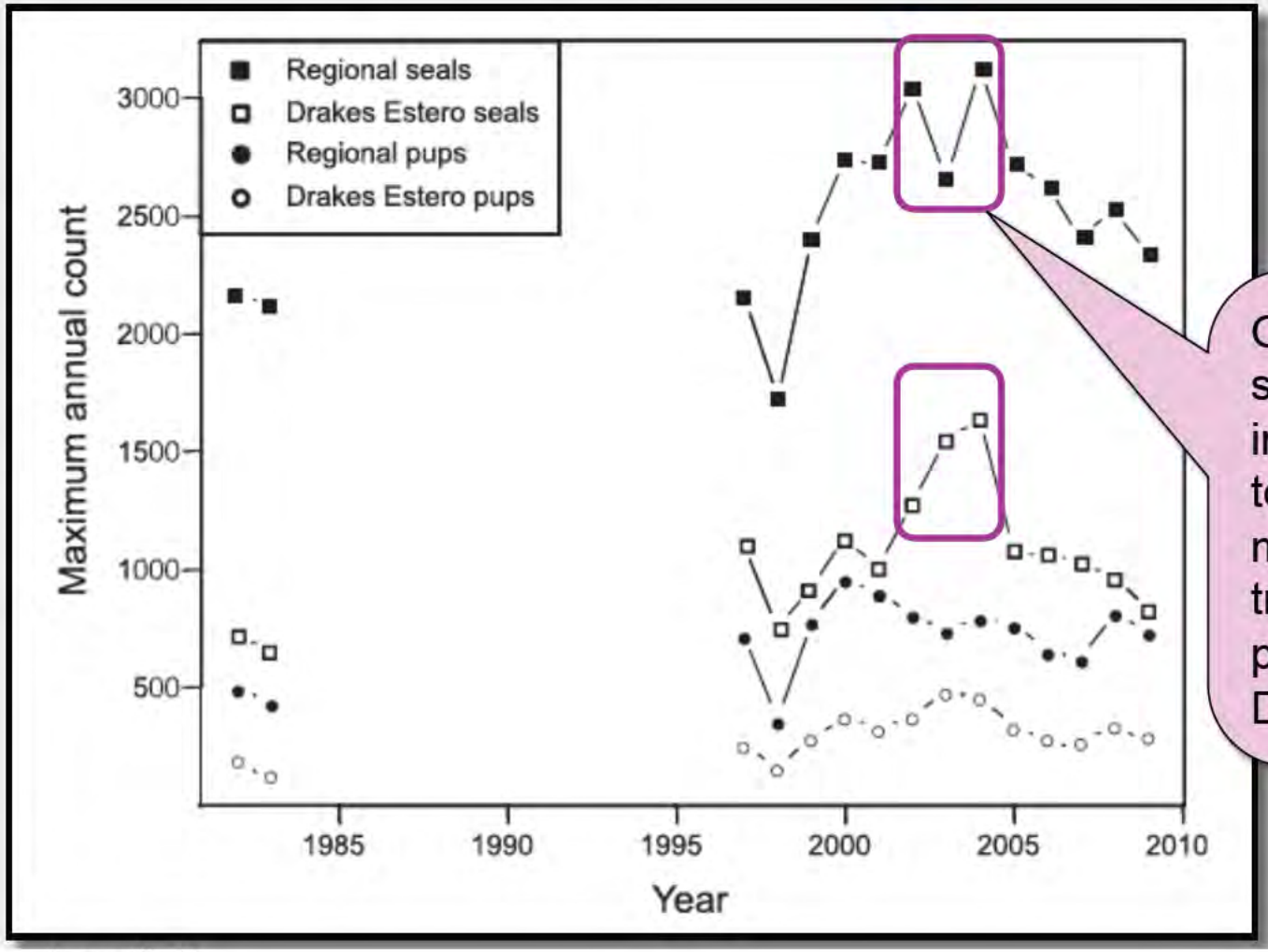
US National Park Service, Point Reyes National Seashore, Point Reyes Station, CA 94956, USA



One rogue elephant seal at Double Point in 2003 + increased total regional seals might explain transient increase in proportional seals in Drakes Estero.

22

Evidence for long-term spatial displacement of breeding and pupping harbour seals by shellfish aquaculture over three decades†

BENJAMIN H. BECKER*, DAVID T. PRESS and SARAH G. ALLEN
US National Park Service, Point Reyes National Seashore, Point Reyes Station, CA 94956, USA

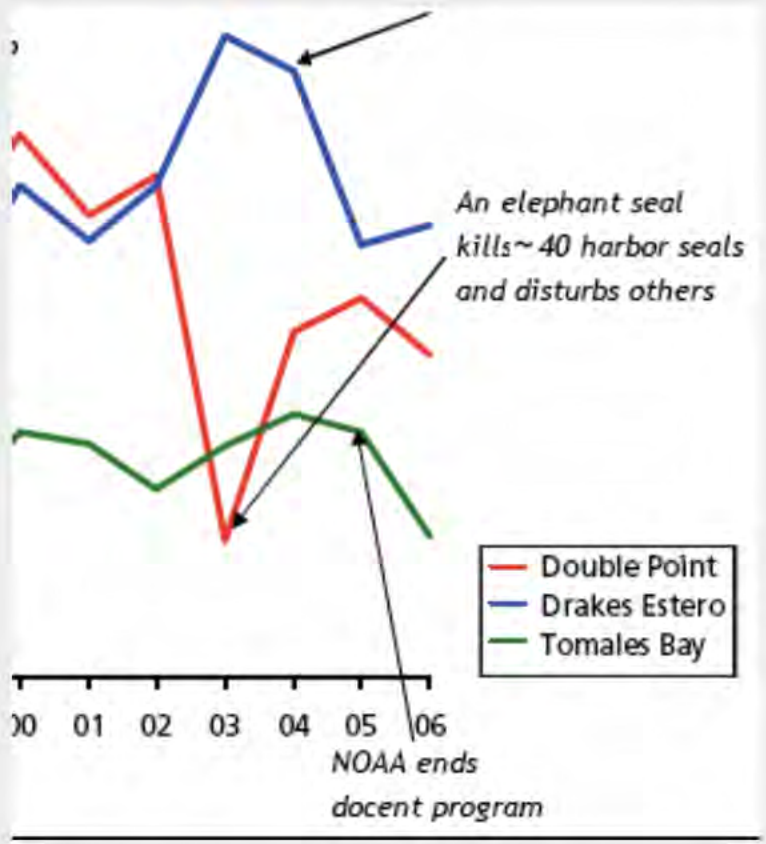
Maximum annual count of seals at nearest colony (*Double Point*). Seals are thought to transit between Double Point and Drakes Estero (Allen Miller, 1988; Grigg *et al.*, 2009), and in 2003 an aggressive elephant seal probably displaced numerous harbour seals from Double Point to Drakes Estero.

We can calculate how many harbor seals went into Drakes Estero. The analysis on slide 26 tells us that around 50% of the pups displaced from Double Point (DP) went into Drakes Estero. The analyses of the long-term relationships predict the same. The mean proportion of pups at Double Point (prop.pup.dp) is 0.296. In 2003, a rogue elephant seal killed 40 seals and chased away ~ 600 seals from Double Point, leaving prop.pup.dp at 0.085. Thus, the rogue elephant seal led to a decrease in prop.pup.dp of 0.211 that equals 260 pups. If ~ 50% of the pups from DP went into Drakes Estero, this would equal around 130 pups displaced into DE. This can be seen visually on the next slide (#24) from an NPS May 2007 document.

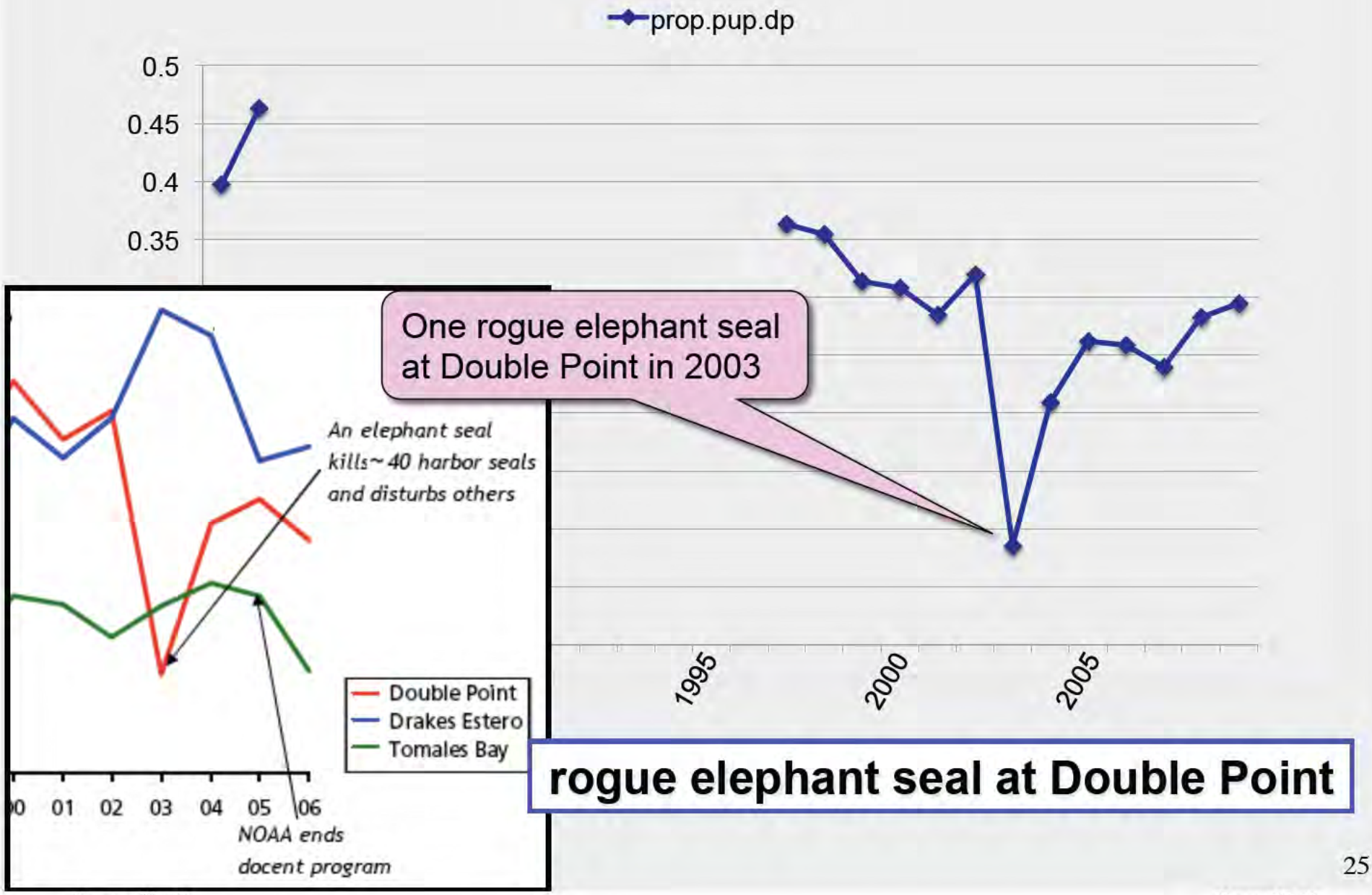
National Park Service
U.S. Department of the Interior
Pacific Coast Science and Learning Center
Research Project Summary May 2007

Harbor Seal Monitoring at Point Reyes National Seashore and Golden Gate National Recreation Area

By Marcus Koenen and Sarah Allen



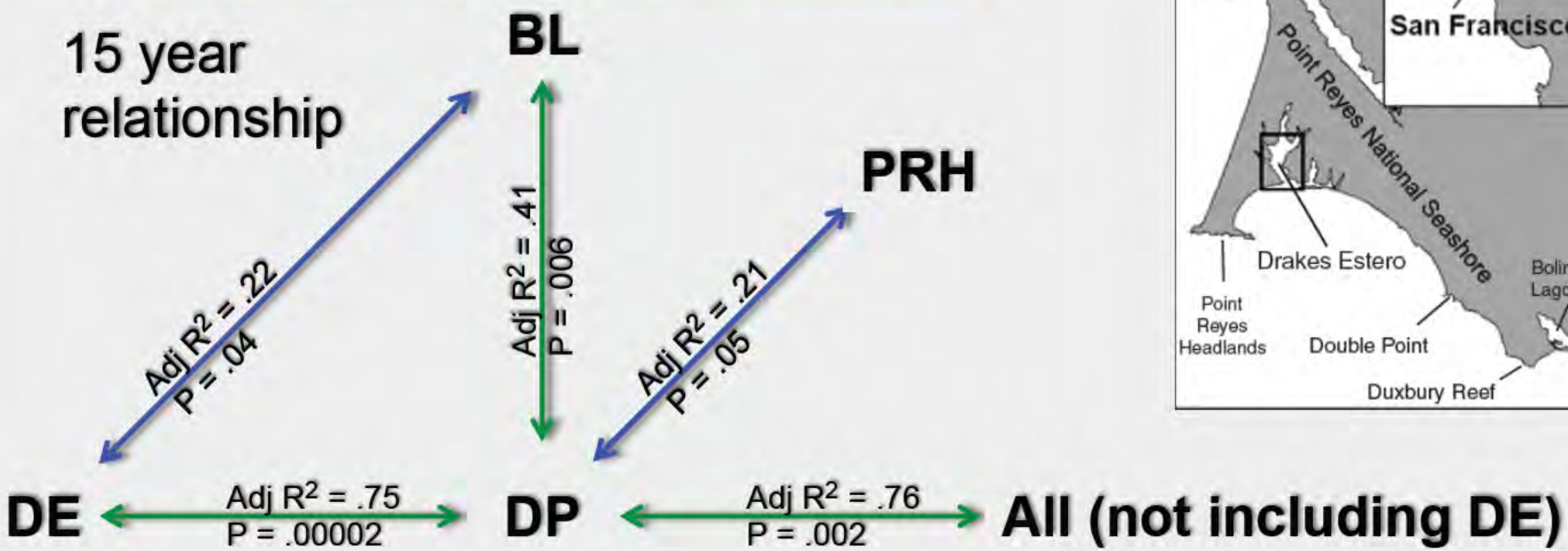
24

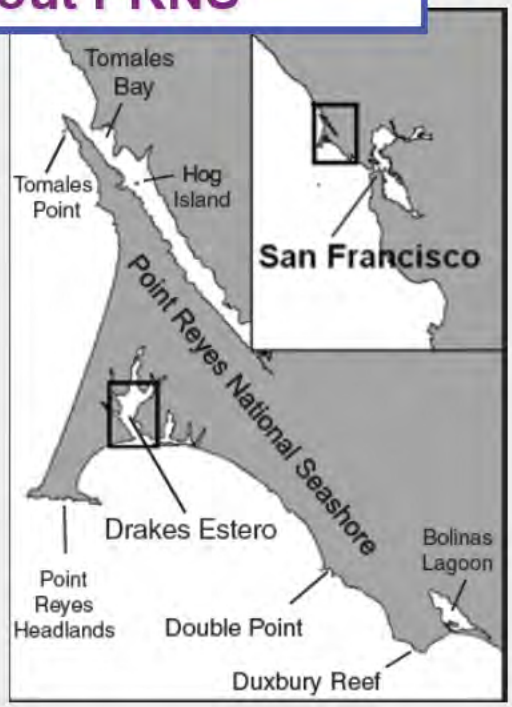


rogue elephant seal at Double Point

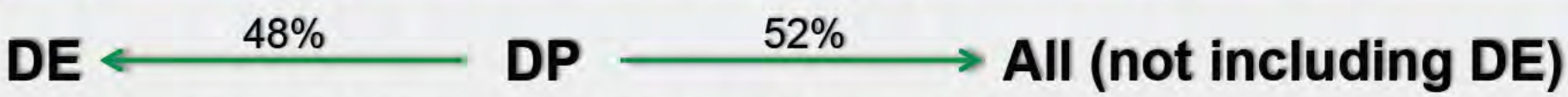
Relationships of Proportion of Pups Throughout PRNS

Regression analysis of Drakes Estero and Double Point against other PRNS sites

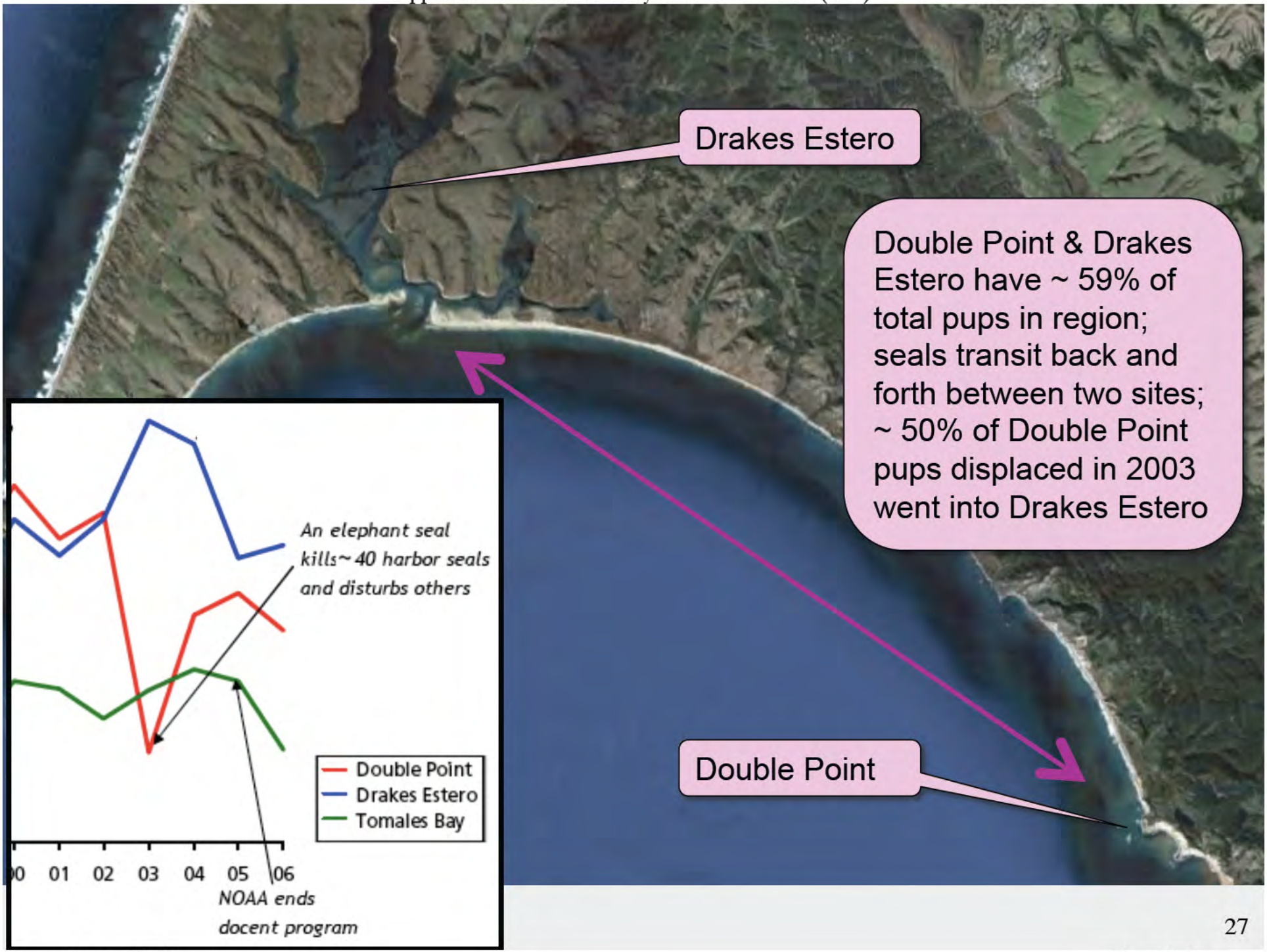


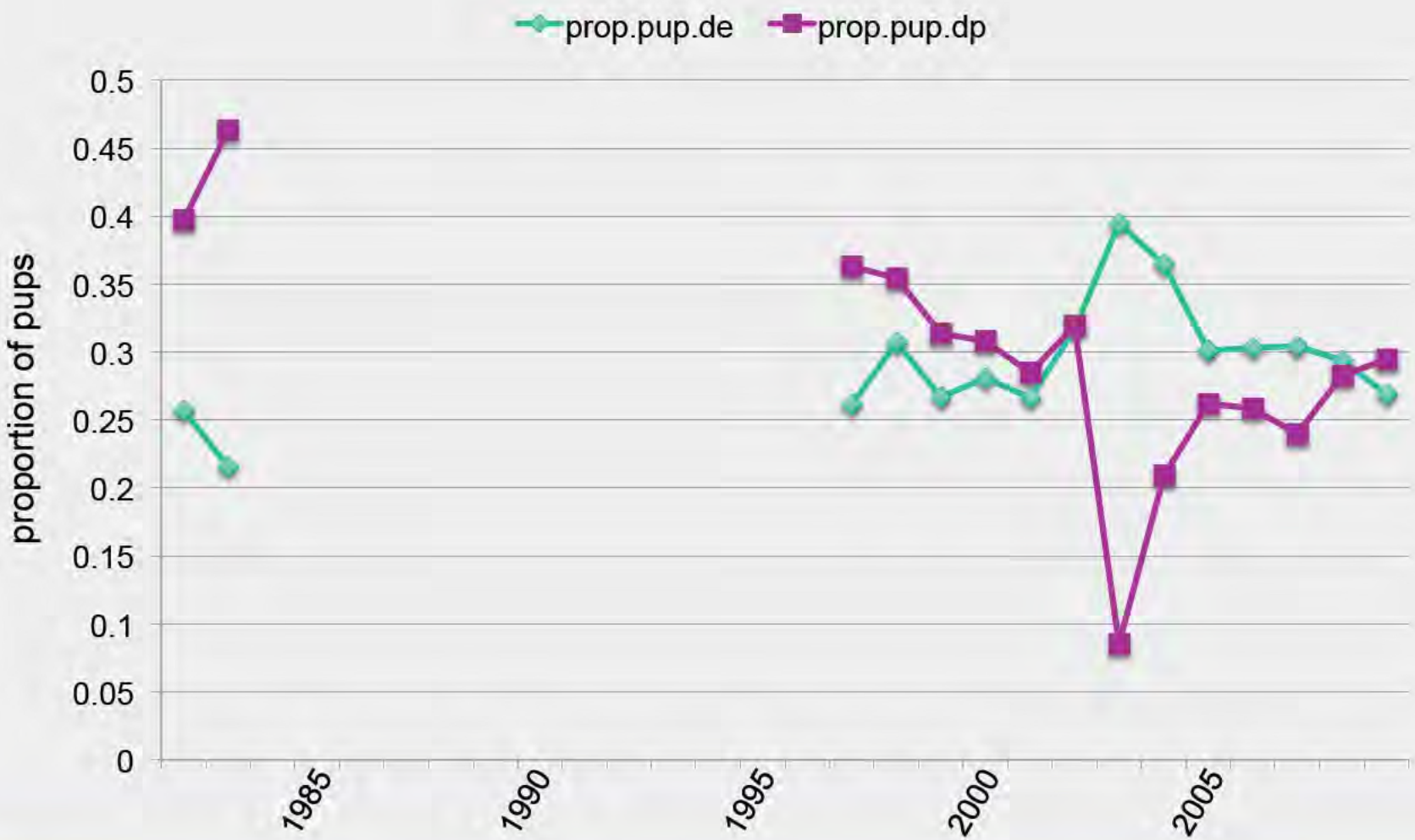


Where did DP pups displaced by elephant seal go in 2003? Overall pattern of displacement in 2003 matches 15 year relationship

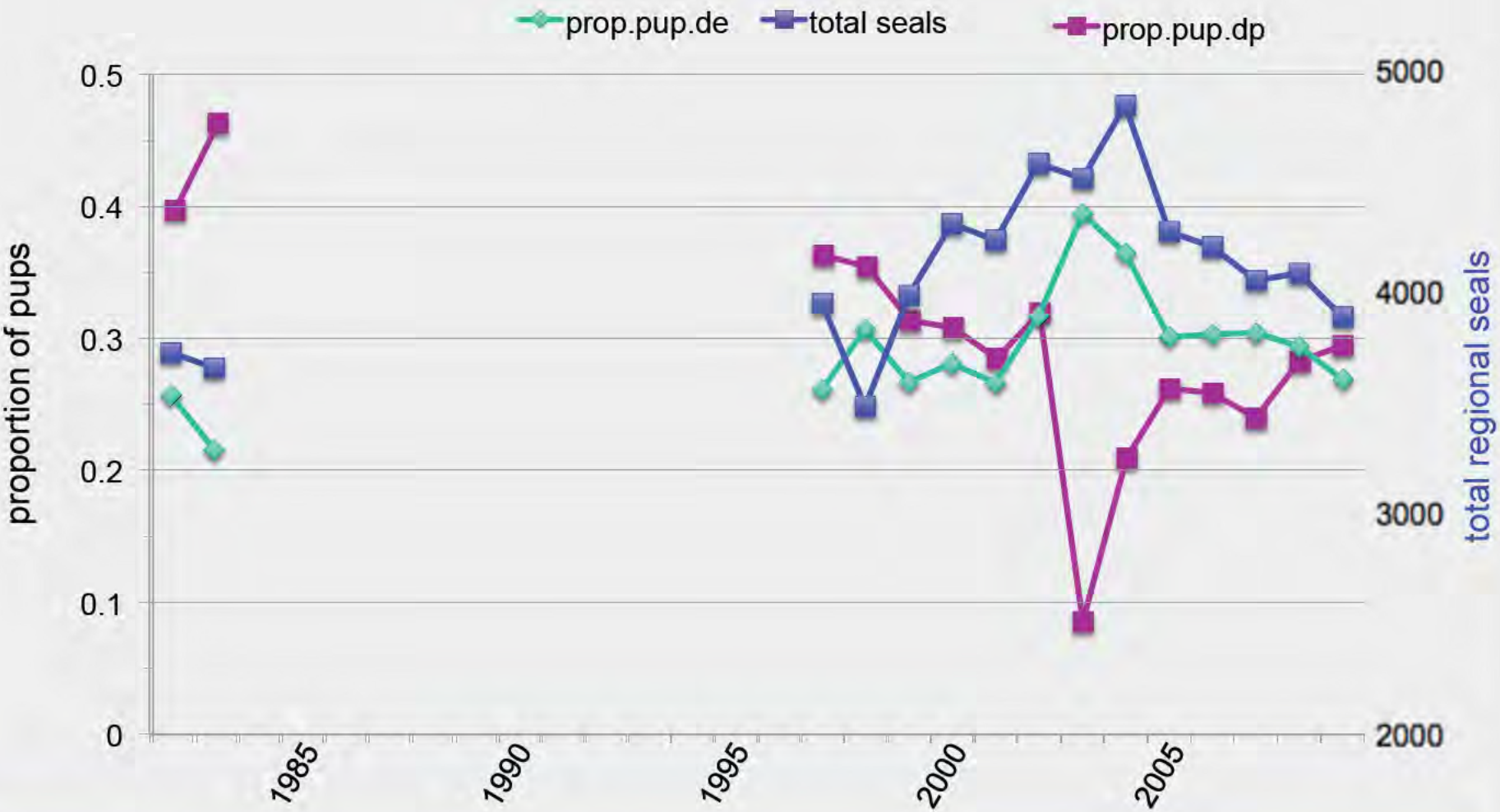


1 year spatial displacement (2003 vs. mean 2000 to 2002)

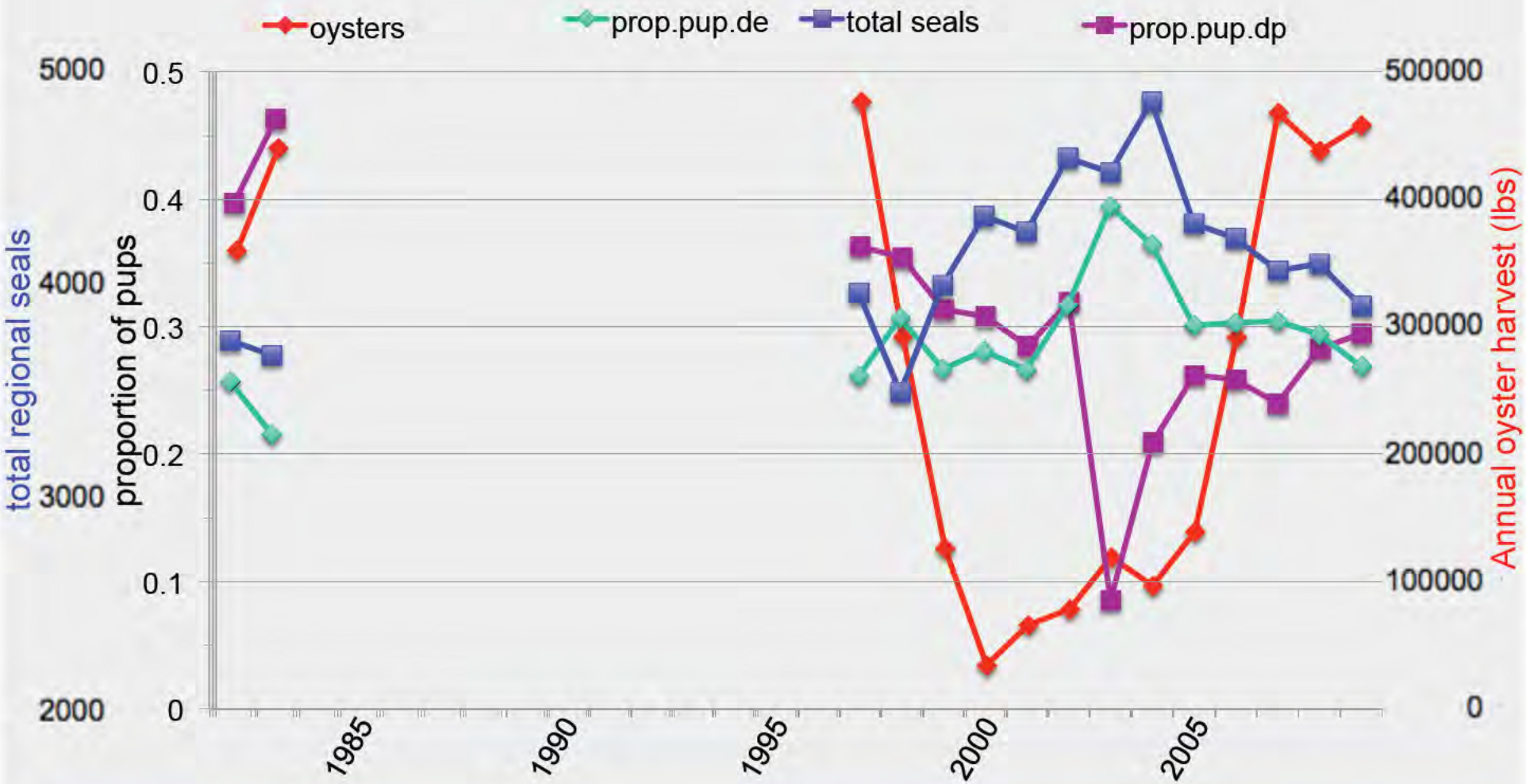

Drakes Estero
Double Point & Drakes Estero have ~ 59% of total pups in region; seals transit back and forth between two sites; ~ 50% of Double Point pups displaced in 2003 went into Drakes Estero
Double Point
An elephant seal kills~40 harbor seals and disturbs others
Double Point
Drakes Estero
Tomales Bay
00
01
02
03
04
05
06
NOAA ends docent program



proportion of pups at DP looks to better correlate …

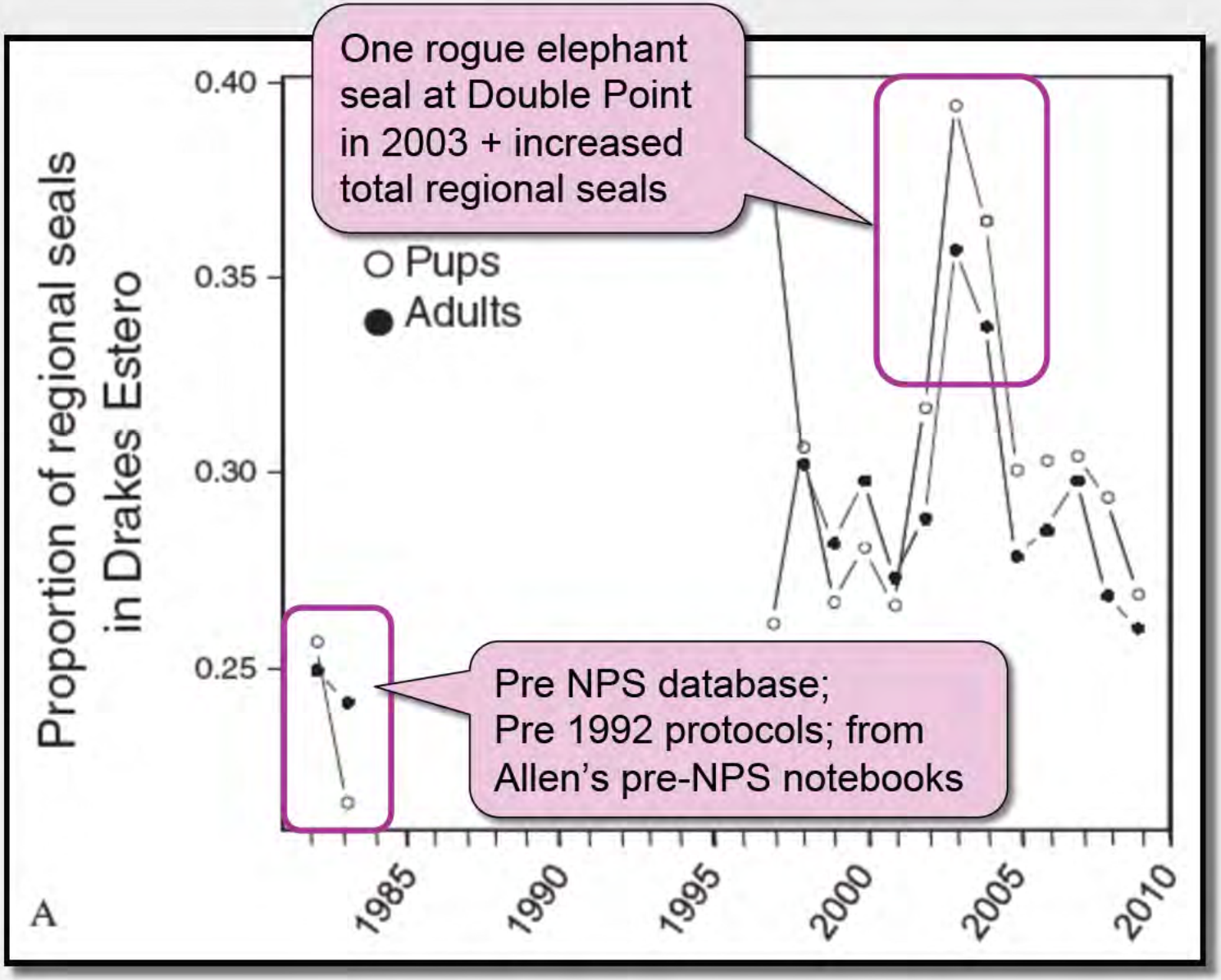


proportion pups at Double Point + total regional seals …



… to the eye look better than annual oyster harvest.

What does statistical regression analysis teach us?



Becker 2011 Figure 3A

Ranking of Models in Becker 2011: Proportion Pups in Drakes Estero

Table 3. A priori models ranked by delta QAICc for the proportion of Point Reyes seal pups and total seals using Drakes Estero. Δi indicates QAICc distance from the best model and wi indicates model weight. Modeling oyster harvest as a continuous variable or low oyster during 1999–2004 gives similar results. Models ranking within the lowest 4 QAICc units (in bold) were used for multimodel inference in table 5. Oyst: low oyster harvest from 2000–2004; DP: Double Point Counts; A: proportion of Drakes Estero seals using subsite A; Dist: anthropogenic disturbance rate. Rankings are similar if using continuous oyster harvest rather than *categorical*

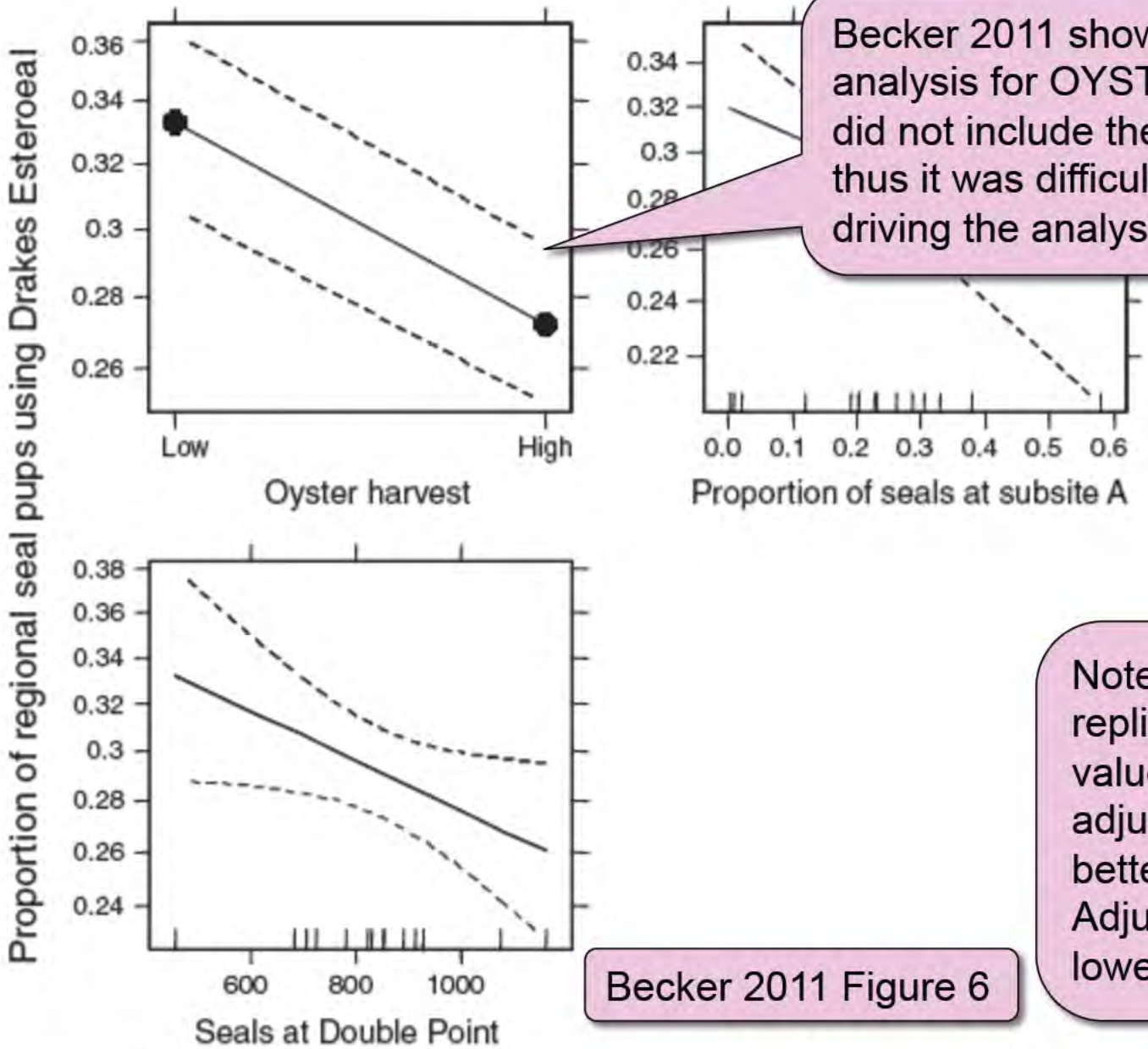
Age class	Model	Δi	wi	r^2
Pup	**Oyst+Double Point (DP)**	**0.0**	**0.35**	**0.51**
	Oyst+DP+A	**1.3**	**0.18**	**0.63**
	Oyst+A	**1.4**	**0.18**	**0.46**
	Oyst+ENSO	**2.6**	**0.09**	**0.42**
	Oyst	**3.3**	**0.06**	**0.26**
	Year	5.0	0.03	0.20
	Oyst+Dist	5.6	0.02	0.32
	Oyst+DP+Dist+A	[illegible]	[illegible]	[illegible]
	DP+Year	6.4	[illegible]	[illegible]
	DP	7.3	[illegible]	[illegible]
	Null	7.7	[illegible]	[illegible]
	Regional pup count	10.3	[illegible]	[illegible]

Prop.pup.de

OYST Hi/Low

Becker's top models included OYST Hi/Low categorical variable.

Proportion pups in Drakes Estero vs. OYST Hi/Low regression analysis

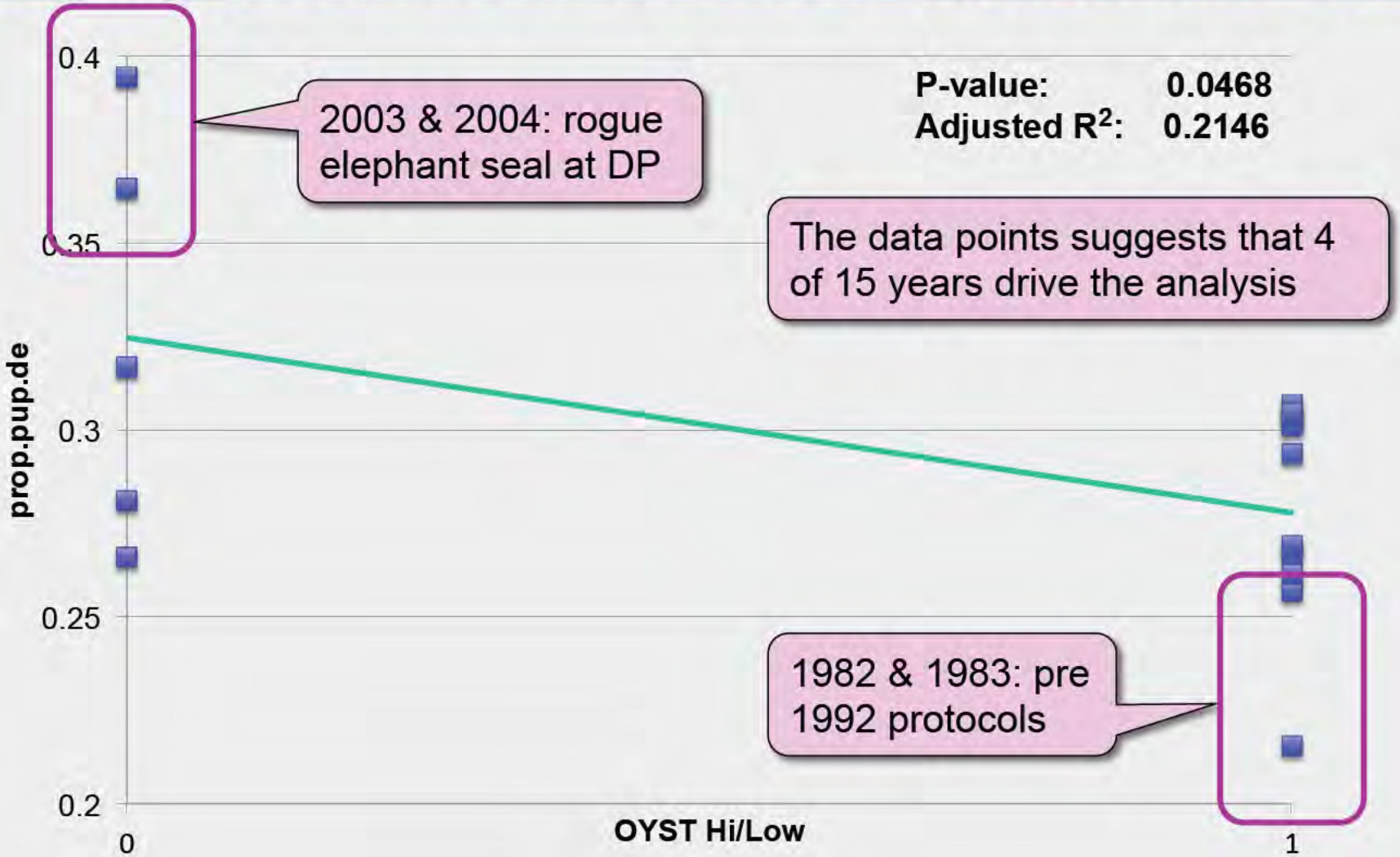


Becker 2011 showed a regression analysis for OYST Hi/Low, but he did not include the data points and thus it was difficult to see what was driving the analysis.

Becker 2011 Figure 6

Note: we can replicate Becker's R^2 values. We used adjusted R^2 as a better measure. Adjusted R^2 is often lower than R^2 value.

Proportion pups in Drakes Estero vs. OYST Hi/Low regression analysis



Proportion pups in Drakes Estero vs. OYST Hi/Low regression analysis

Modeling the effects of El Niño, density-dependence, and disturbance on harbor seal (*Phoca vitulina*) counts in Drakes Estero, California: 1997–2007

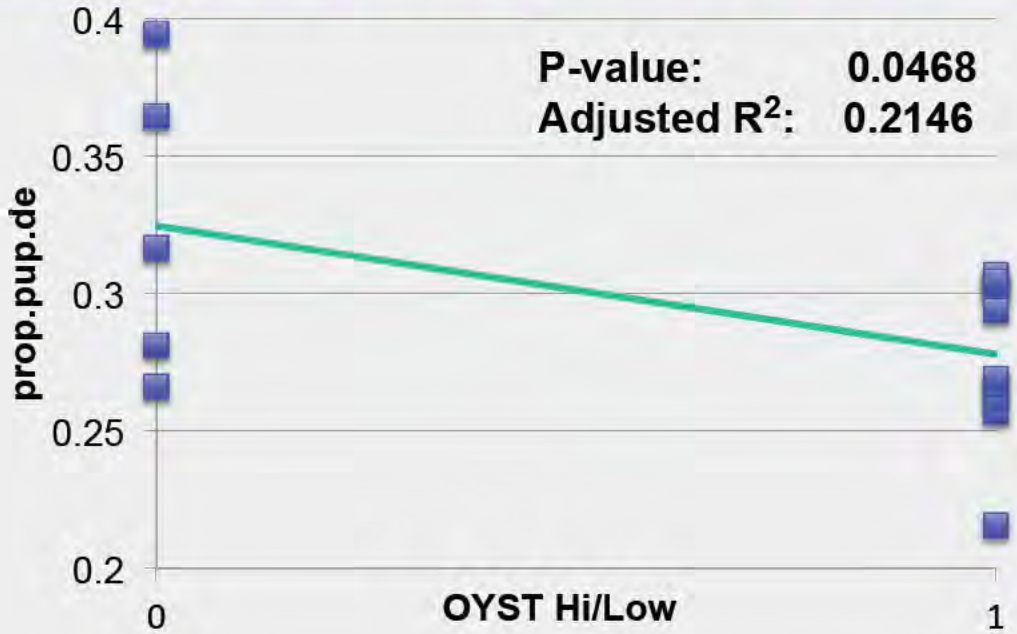
MARINE MAMMAL SCIENCE, 25(1): 1–18 (January 2009)

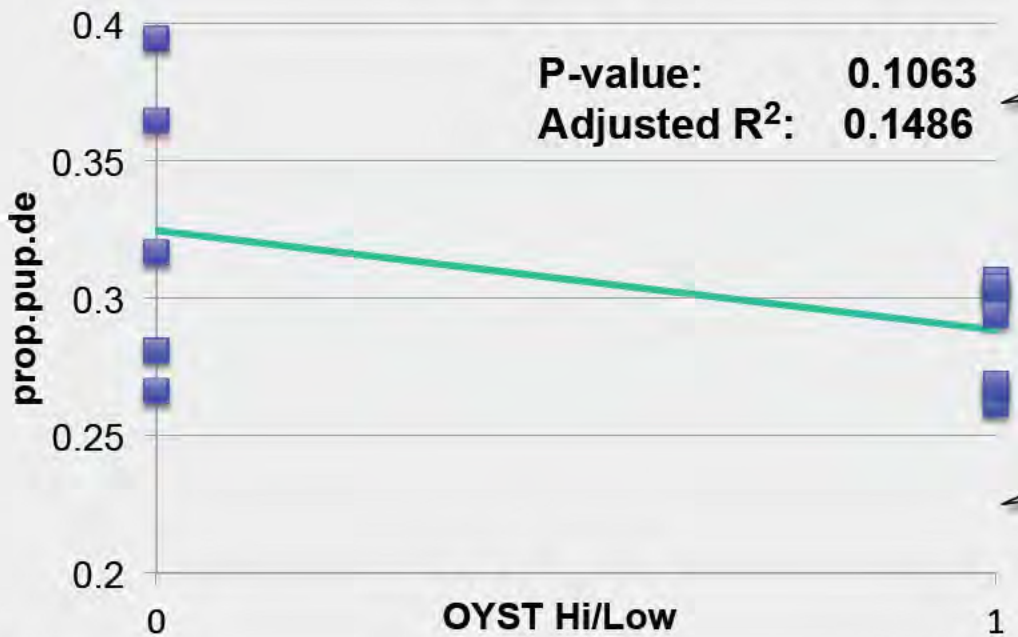
The 2008 pupping season presented an opportunity to investigate the immediate effect of a change in oyster operations. In 2008, the California Coastal Commission

less useful in the future. For this reason, it is not appropriate to include the 2008 data in the models because of this large change in management.

Becker later corrected his published paper and noted that there was no management change in 2008. The 1992 protocols and 1996 kayak ban posed very significant changes in management.
"*For this reason, it is not appropriate to include the*" 1982 & 1983 "*data in the models because of this large change in management.*"

Proportion pups in Drakes Estero vs. OYST Hi/Low regression analysis

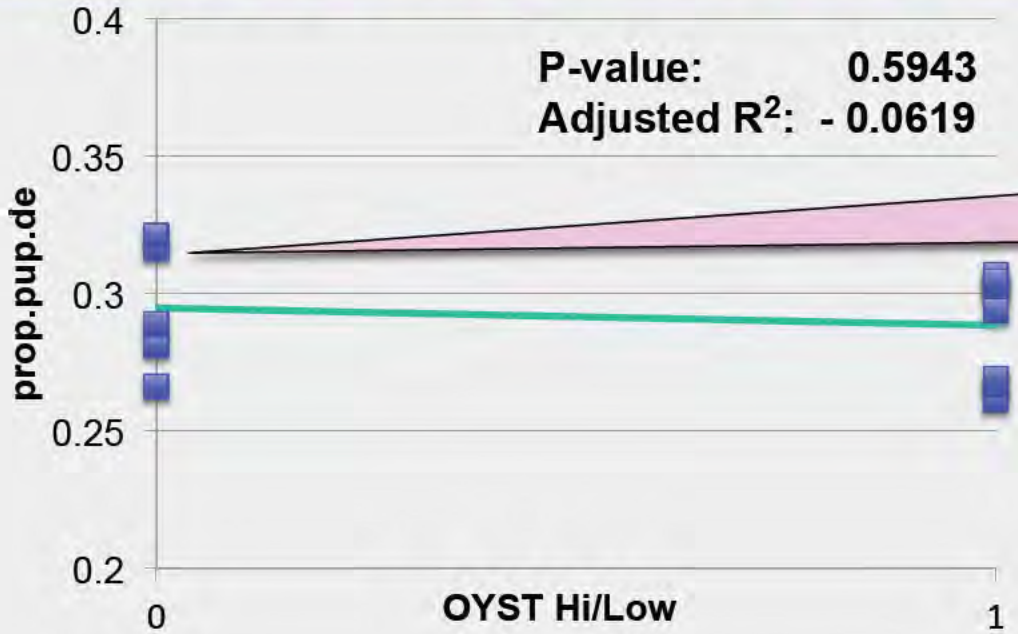




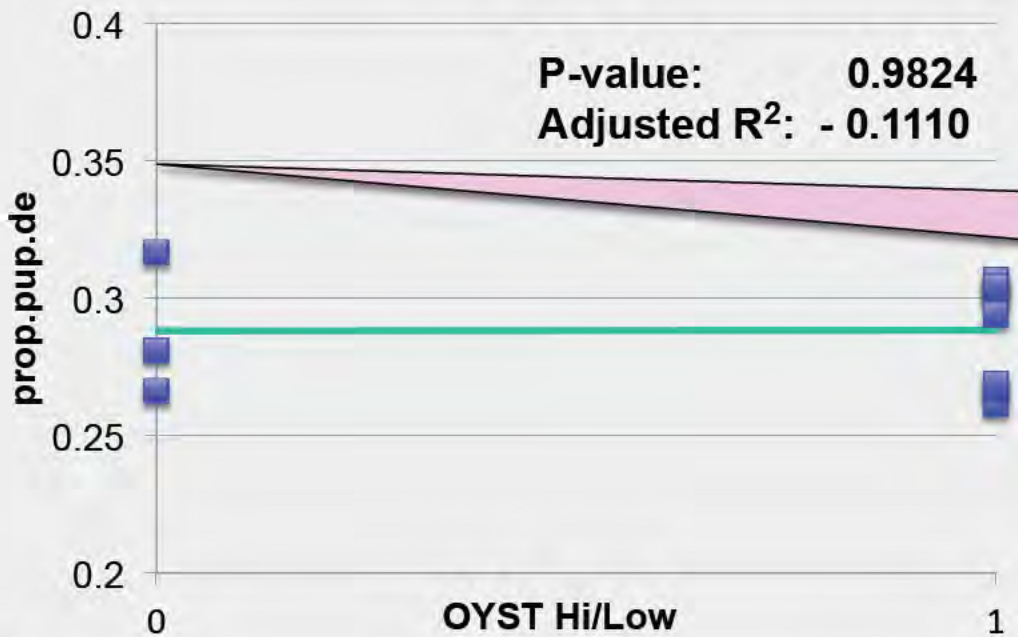
P-value no longer significant (> 0.05)

Removed 1982 & 1983 from analysis

Proportion pups in Drakes Estero vs. OYST Hi/Low regression analysis



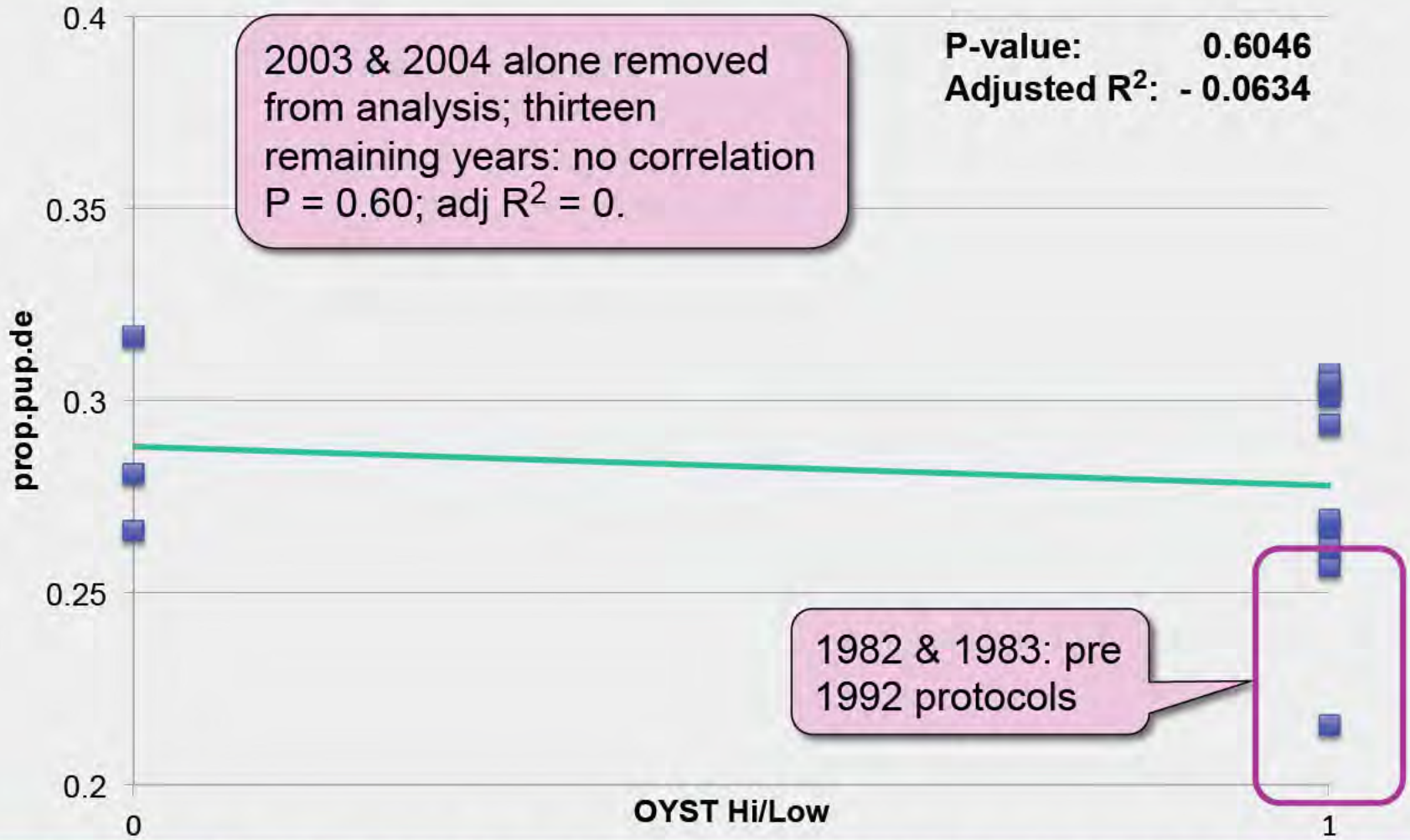
2003 & 2004 adjusted for rogue elephant seal



1982, 1983, 2003, & 2004 removed from analysis

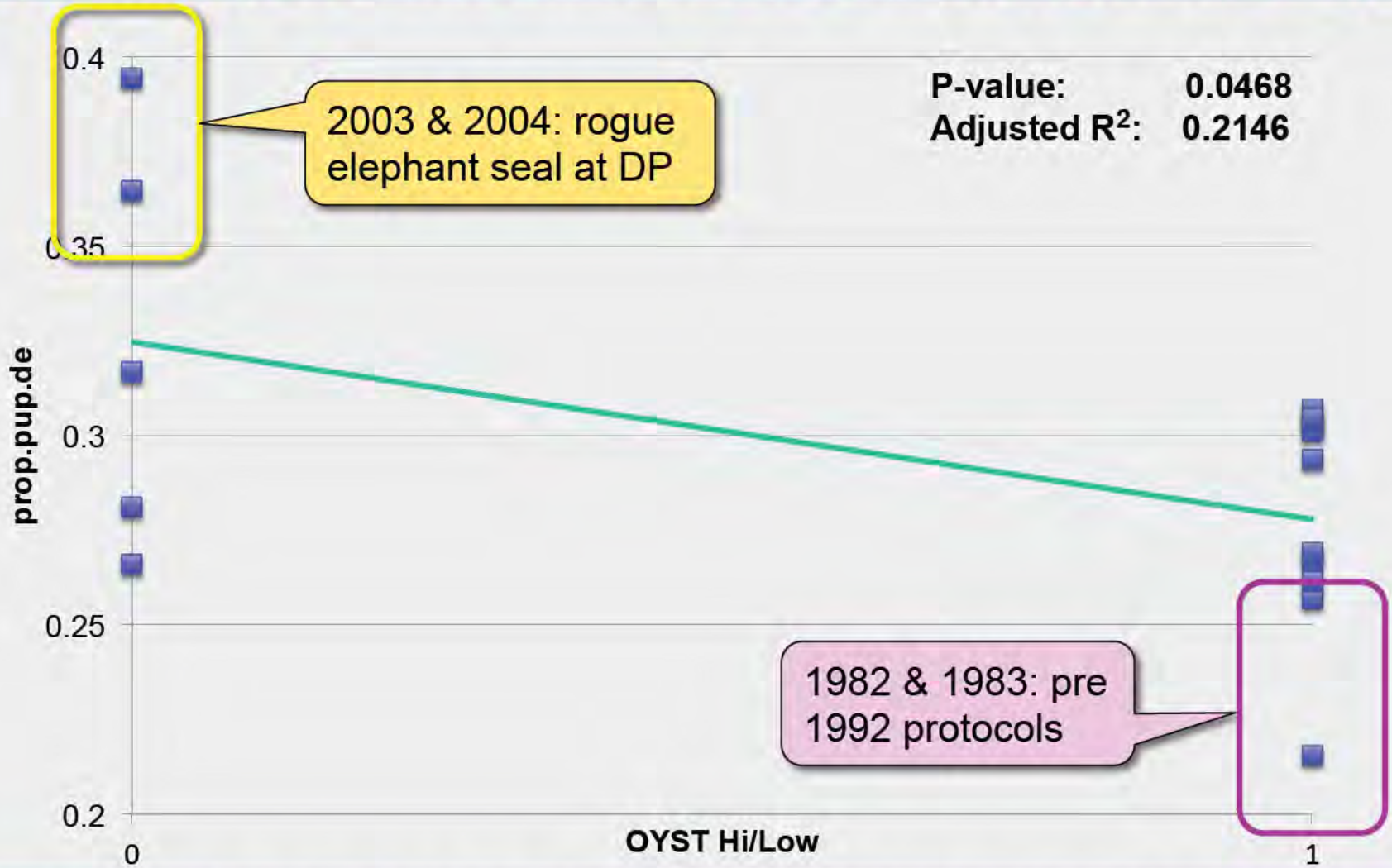
Eleven remaining years: no correlation P = 0.98; adj R^2 = 0.

Proportion pups in Drakes Estero vs. OYST Hi/Low regression analysis



Conclusion: what is driving OYST Hi/Low analysis is not DBOC years 2005-2009, and not long-term trend, but rather 2003 & 2004: if remove 2003 & 2004 only, the remaining 13 years show no significance

Proportion pups in Drakes Estero vs. OYST Hi/Low regression analysis



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Ranking of Models in Becker 2011: Proportion Pups in Drakes Estero

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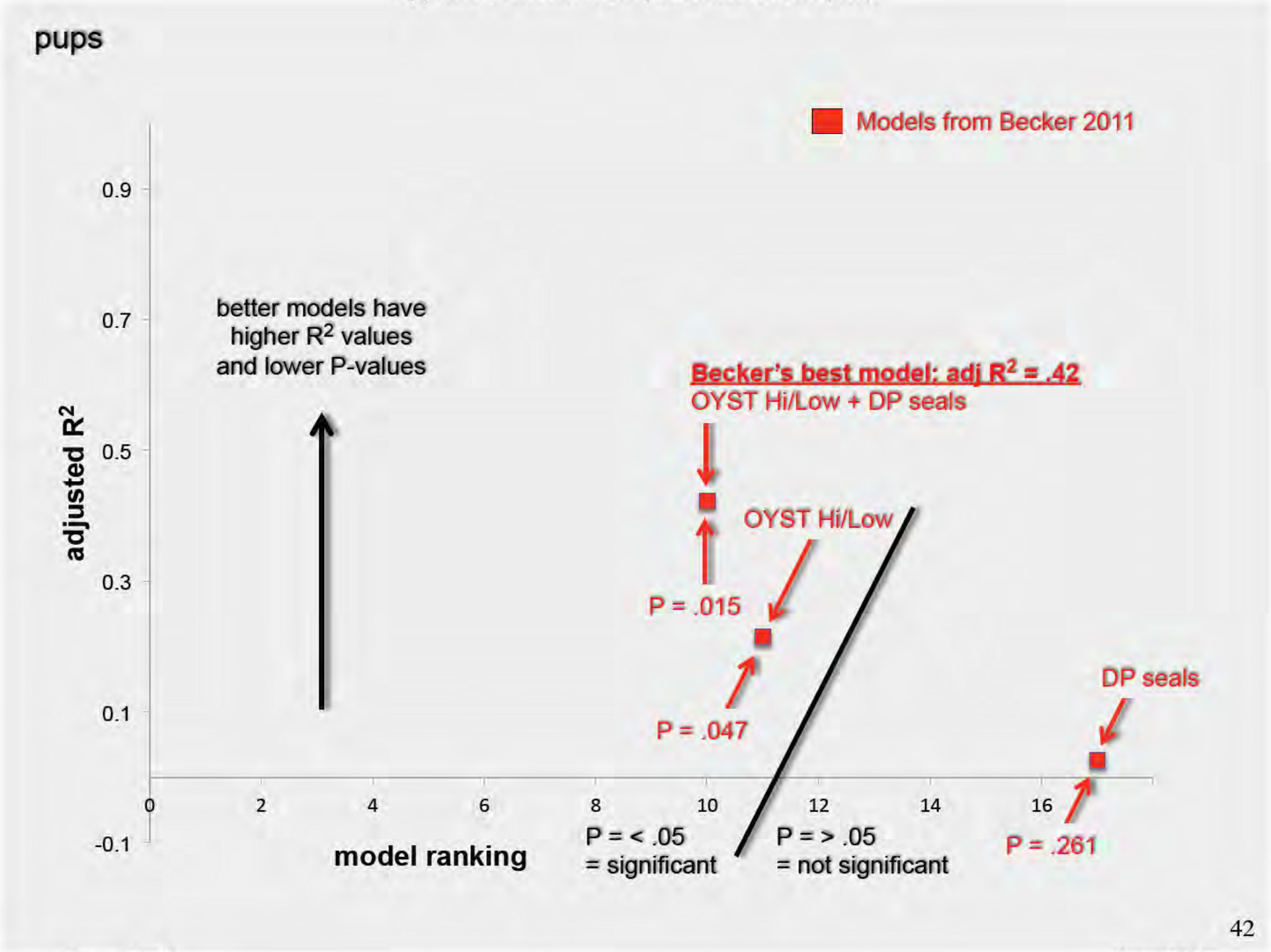
	Oyst	**3.3**	**0.06**	**0.26**
	Year	5.0	0.03	0.20
	Oyst+Dist	5.6	0.02	0.32
	Oyst+DP+Dist+A	6.3	0.01	0.66
	DP+Year	6.4	0.01	0.29
	DP	7.3	0.01	0.12
	Null	7.7	0.01	0.00
	Regional pup count	10.3	0.00	0.02

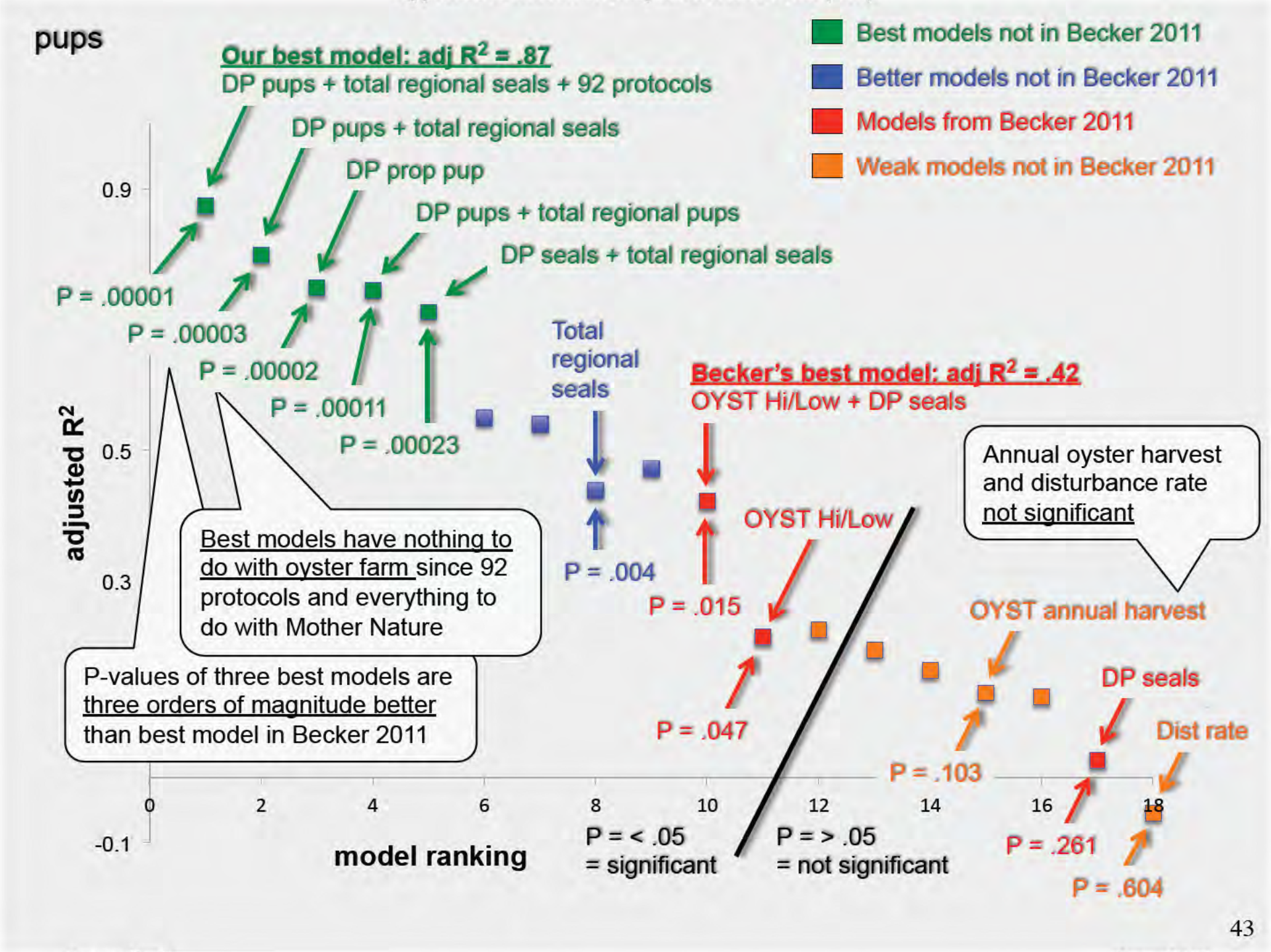
Why was OYST Hi/ Low in all of Becker's best models? If the rogue elephant seal in 2003 was so important, why didn't it come up in Becker's best models, or did it?

Ranking of Models in Becker 2011: Proportion Pups in Drakes Estero

Table 3. A priori models ranked by delta QAICc for the proportion of Point Reyes seal pups and total seals using Drakes Estero. Δi indicates QAICc distance from the best model and wi indicates model weight. Modeling oyster harvest as a continuous variable or low oyster during 1999–2004 gives similar results. Models ranking within the lowest 4 QAICc units (in bold) were used for multimodel inference in table 5. Oyst: low oyster harvest from 2000–2004; DP: Double Point Counts; A: proportion of Drakes Estero seals using subsite A; Dist: anthropogenic disturbance rate. Rankings are similar if using continuous oyster harvest rather than *categorical*

Dr. Becker provided the NPS data used in his study (see pages 5-8). Having explained why OYST Hi/Low is not a good model, we next examined other potential models. We found that the best models all included Double Point (DP), usually DP pups, and usually total regional seals. For Tables 3 & 4, Becker used the counts of total seals at DP. This is inconsistent with Becker's representation of Sandbar A as a proportion of DE seals. We examined DP seals, DP pups, proportion of pups at DP, and proportion of seals at DP. Measures of DP pups and total regional seals gave us the best models – models that were far superior to Becker's and with P-values three orders of magnitude better than Becker's best model. OYST Hi/Low is not a significant predictor after controlling for DP pups, total regional seals, + 92 protocols.


pups
Models from Becker 2011
0.9
0.7
0.5
0.3
0.1
-0.1
adjusted R2
better models have
higher R2 values
and lower P-values
Becker's best model: adj R2 = .42
OYST Hi/Low + DP seals
OYST Hi/Low
P = .015
P = .047
DP seals
P = .261
0
2
4
6
8
10
12
14
16
model ranking
P = < .05
= significant
P = > .05
= not significant


pups
Best models not in Becker 2011
Better models not in Becker 2011
Models from Becker 2011
Weak models not in Becker 2011
Our best model: adj R² = .87
DP pups + total regional seals + 92 protocols
DP pups + total regional seals
DP prop pup
DP pups + total regional pups
DP seals + total regional seals
P = .00001
P = .00003
P = .00002
P = .00011
P = .00023
Total regional seals
P = .004
Becker's best model: adj R² = .42
OYST Hi/Low + DP seals
P = .015
OYST Hi/Low
P = .047
OYST annual harvest
P = .103
DP seals
P = .261
Dist rate
P = .604
Annual oyster harvest and disturbance rate not significant
Best models have nothing to do with oyster farm since 92 protocols and everything to do with Mother Nature
P-values of three best models are three orders of magnitude better than best model in Becker 2011
adjusted R²
0.9
0.5
0.3
-0.1
0
2
4
6
8
10
12
14
16
18
model ranking
P = < .05
= significant
P = > .05
= not significant

Ranking of Models in and not in Becker 2011: Proportion Pups in DE

notes	In Becker?	rank	model	P-value	Adj R^2
Top multi-model	no	1	DP pups + total regional seals + 92 protocols	0.00001	0.87357
Top multi-model class	no	2	DP pups + total regional seals	0.00003	0.79850
Top single model	no	3	DP proportional pups	0.00002	0.74851
Best multi-model class	no	4	DP pups + total regional pups	0.00011	0.74453
Best multi-model class	no	5	DP seals + total regional seals	0.00023	0.71156
Best (not on slide #43)	no	(6*)	DP proportion seals	0.00033	0.61526
Better multi-model	no	6	Double Point (DP) pups + OYST Hi/Low	0.00330	0.54992
Better multi-model	no	7	Double Point (DP) pups + 92 protocols	0.00375	0.54016
Better single model	no	8	Total regional seals	0.00428	0.43832
Better multi-model	no	9	Double Point pups + OYST annual harvest	0.00854	0.47256
Becker best multi-model	yes	10	OYST Hi/Low + Double Point (DP) seals	0.01474	0.42230
Becker best single model	yes	11	OYST Hi/Low	0.04680	0.21456
Weak single model	no	12	92 protocols	0.04201	0.22589
Weak single model	no	13	Double Point (DP) pups	0.05640	0.19475
Weak single model	no	14	Total regional pups	0.07519	0.16369
Weak single model	no	15	OYST annual harvest	0.10279	0.12935
Weak single model	no	16	OYST Hi/Low w/2005 Low	0.10825	0.12362
Weak single model	yes	17	Double Point (DP) seals	0.26092	0.02653
Weak single model	no	18	disturbance rate	0.60439	-0.05406

Becker's best model -- OYST Hi/Low – has no impact on top five models

notes	rank	model	P-value	Adj R^2
Top multi-model	1	DP pups + total regional seals + 92 protocols	0.00001	0.87357
With OYST Hi/Low		DP pups + total regional seals + 92 protocols + OYST Hi/Low	0.00004	0.87163
		P-value for OYST Hi/Low = 0.3826 (not significant)		
Top multi-model class	2	DP pups + total regional seals	0.00003	0.79850
With OYST Hi/Low		DP pups + total regional seals + OYST Hi/Low	0.00016	0.78272
		P-value for OYST Hi/Low = 0.7266 (not significant)		
Top single model	3	DP proportional pups	0.00002	0.74851
With OYST Hi/Low		DP proportional pups + OYST Hi/Low	0.00010	0.74799
		P-value for OYST Hi/Low = 0.3434 (not significant)		
Best multi-model class	4	DP pups + total regional pups	0.00011	0.74453
With OYST Hi/Low		DP pups + total regional pups + OYST Hi/Low	0.00037	0.74518
		P-value for OYST Hi/Low = 0.3318 (not significant)		
Best multi-model class	5	DP seals + total regional seals	0.00023	0.71156
With OYST Hi/Low		DP seals + total regional seals + OYST Hi/Low	0.00106	0.69020

None of our top five models included OYST Hi/Low. When the five models were run using multi-variant regression analysis and an additional independent variable – OYST Hi/Low – was added, the P-value increased (i.e., significance decreased), the adjusted R^2 either decreased or did not significantly change, and the contribution of OYST Hi/Low was not significant. In contrast to the conclusion in Becker et al. 2011, OYST Hi/Low did not have a significant impact on the proportion of pups in Drakes Estero.

An important test of the models: how robust are the models without 2003 & 2004? (i.e., without the rogue elephant seal at DP in 2003)

Top model: DP pups + total regional seals + 92 protocols

		w/o '03 & '04 → with other 13 yrs		
P-value:	0.00001		P-value:	0.005
Adjusted R^2:	0.87		Adjusted R^2:	0.65
	highly significant			highly significant

Becker's best model: OYST Hi/Low + DP seals

		w/o '03 & '04 → with other 13 yrs		
P-value:	0.015		P-value:	0.874
Adjusted R^2:	0.42		Adjusted R^2:	0 (negative)
	significant			not significant

If the models represent a significant long-term pattern, then they should still be significant with only 13 of 15 years. Becker's best models fail that test. Becker's best models (with OYST Hi/Low) depend on '03 & '04 whereas the much better models (DP pups + total regional seals) do not.

More complete test of models: how robust are they without 2003 & 2004?

notes	rank	model	P-value	Adj R^2
Top multi-model	1	DP pups + total regional seals + 92 protocols	0.00001	0.87357
Without 2003 & 2004		DP pups + total regional seals + 92 protocols	0.00529	0.65423
Top single model	3	DP proportional pups	0.00002	0.74851
Without 2003 & 2004		DP proportional pups + OYST Hi/Low	0.00478	0.48734
Becker's best multi-model	10	OYST Hi/Low + DP seals	0.01474	0.42230
Without 2003 & 2004		OYST Hi/Low + DP seals	0.87444	- 0.16823
Becker's best single model	11	OYST Hi/Low	0.04680	0.21456
Without 2003 & 2004		OYST Hi/Low	0.60458	- 0.06344

The analysis of Becker 2011 presented earlier here showed that the statistical significance using OYST Hi/Low depended upon 2003 & 2004, the years heavily influenced by the rogue elephant seal at Double Point. As shown above, without 2003 & 2004, OYST Hi/Low, either as Becker's best single model or as Becker's top model with DP seals, was no longer significant. The remaining 13 of 15 years showed no statistical significance. In contrast, our top multi-model and top single model both retained their statistical significance without 2003 & 2004, suggesting that these models represent meaningful predictors that go beyond the rogue elephant seal in 2003 that drove the transient spatial displacement.

Becker 2011 Did Not Take the Advice of National Academy of Sciences

notes	rank	model	P-value	Adj R^2
Top multi-model	1	DP pups + total regional seals + 92 protocols	0.00001	0.87357
Top multi-model class	2	DP pups + total regional seals	0.00003	0.79850
Top single model	3	DP proportional pups	0.00002	0.74851
Best multi-model class	4	DP pups + total regional pups	0.00011	0.74453
Best multi-model class	5	DP seals + total regional seals	0.00023	0.71156

Four of the top five models include total regional seals or pups, and the 5th uses total regional pups to derive the proportion. This analysis was suggested by NAS panel member Dr. Francis O'Beirn (Trinity College Dublin and leader at the Marine Institute in Galway) at the September 4, 2008 meeting of the NAS panel. After Becker's presentation, Dr. O'Beirn noted that seals increased in 2002-2004 and then decreased in 2005 throughout the region, and was thus unlikely to be due to the oyster farm.

> Dr. Francis O'Beirn: *My point is that during the period that you're apportioning it to aquaculture, which is the latter years, 2005, 2006, and 07, a similar decrease has been observed* [at other regional sites]
>
> Dr. Ben Becker: *I did not mean to imply that there is any relationship to the total population size in the estero declining in relation to mariculture … The paper was talking about subsites in the upper estero related to mariculture.*

Dr. Becker agreed with Dr. O'Beirn. That was a key exchange. But Becker 2011 never examined the relationship of the proportion of pups in DE vs. total regional seals. That model alone is better than Becker's best model, and in combination with other variables, the top models are far superior (three orders of magnitude more significant).

Proportion and Effect Size of Pups and Seals in Drakes Estero

Variable	Logit coefficients		Proportional change		Effect size	
	Pups	Total	Pups	Total	Pups	Total
Intercept	−0.26±0.19	−0.37±0.16				
Low oyster (low/high)	−0.27±0.08 (0.05)	−0.23±0.07 (0.03)	−0.07±0.02	−0.05±0.02	−65±18	−192±58
Double Point (per 100 seals)	−0.04±0.02	−0.04±0.02	−0.010±0.005	−0.010±0.005	−10±5	−36±18
Subsite A (low to high)	−0.43±0.22	−0.11±0.07	−0.09±0.05	−0.03±0.02	−91±51	−106±71
Oyster (per 100,000 lbs)*	−0.06±0.02	−0.08±0.03	−0.019±0.006	−0.020±0.007	−19±6	−71±25

Variable	Proportional change		Effect size	
	Pups	Total	Pups	Total
Intercept				
Low oyster (low/high)	−0.07±0.02	−0.05±0.02	−65±18	−192±58
Double Point (per 100 seals)	−0.010±0.005	−0.010±0.005	−10±5	−36±18
Subsite A (low to high)	−0.09±0.05	−0.03±0.02	−91±51	−106±71
Oyster (per 100,000 lbs)*	−0.019±0.006	−0.020±0.007	−19±6	−71±25

Effect size for OYST Hi/Low and Double Point seals is similar

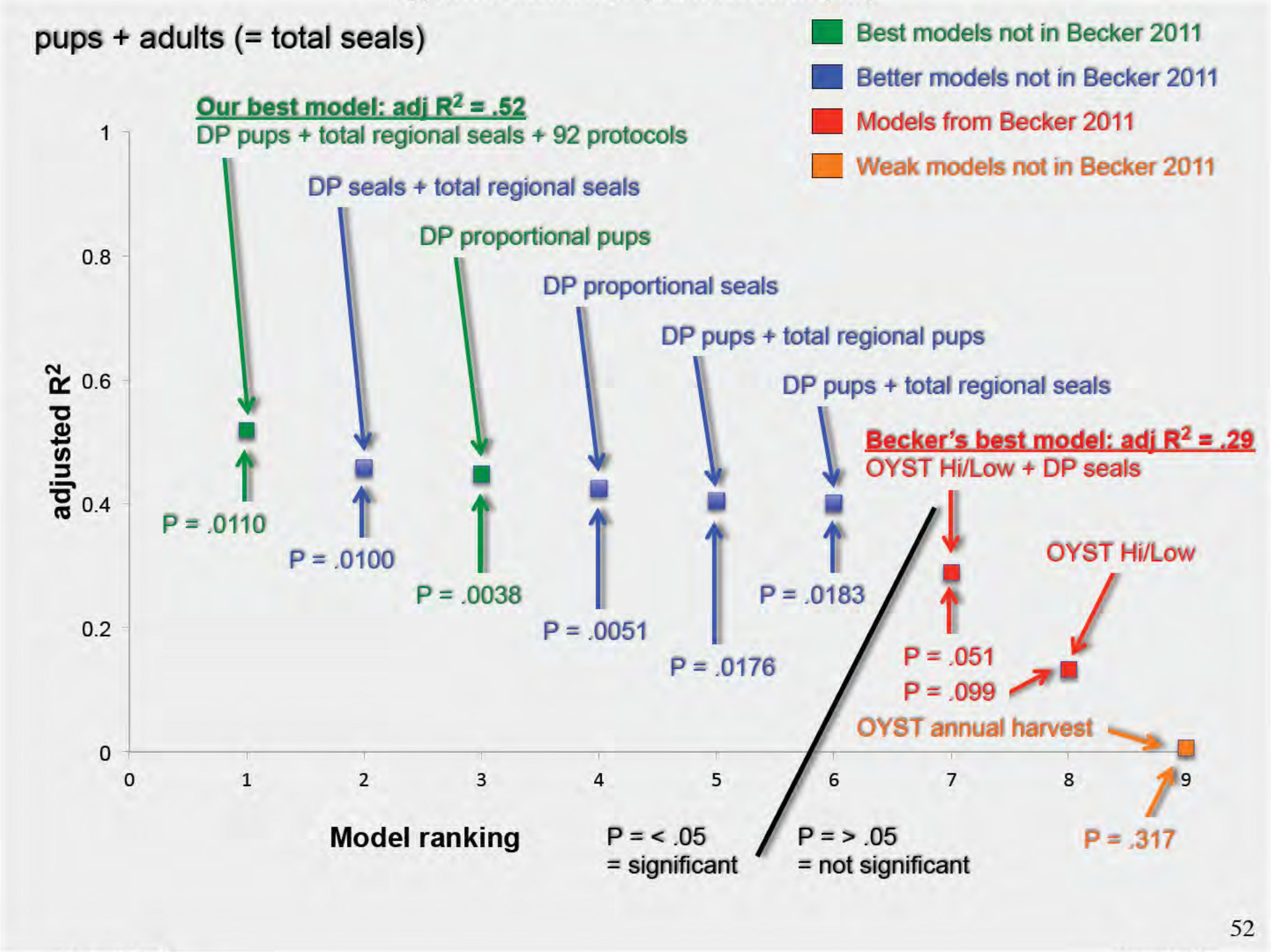
Proportion and Effect Size of Pups in Drakes Estero

model	variable	Prop. change pups	Pup effect size
DP pups + total reg seals + 92 protocols	**Double Point (DP) pups**	**- 10.2 +/- 1.5%**	**- 103 +/- 15**
BEST MODEL	**Total regional seals**	**+ 8.9 +/- 2.0%**	**+ 90 +/- 20**
	92 protocols	**+ 3.8 +/- 1.3%**	**+ 38 +/- 13**
	If add OYST Hi/Low, no significant improvement	Not significant	Not significant
DP pups + total regional seals	Double Point pups	- 9.9 +/- 2.1%	- 100 +/- 21
	Total regional seals	+ 11 +/- 1.7%	+ 111 +/- 17
DP proportional pups (to total reg. pups)	DP proportional pups	- 16.8 +/- 2.6%	- 170 +/- 26
OYST Hi/Low + DP seals (Becker's best)	DP seals	- 9 +/- 4%	- 91 +/- 40
	OYST Hi/Low	- 6.0 +/- 1.9%	- 61 +/- 19
OYST Hi/Low	OYST Hi/Low	- 4.7 +/- 2.1%	- 48 +/- 21
OYST annual harvest	OYST annual harvest	Not significant	Not significant

Ranking of Models in Becker 2011: Proportion Seals in Drakes Estero

Table 3. A priori models ranked by delta QAICc for the proportion of Point Reyes seal pups and total seals using Drakes Estero. Δi indicates QAICc distance from the best model and wi indicates model weight. Modeling oyster harvest as a continuous variable or low oyster during 1999–2004 gives similar results. Models ranking within the lowest 4 QAICc units (in bold) were used for multimodel inference in table 5. Oyst: low oyster harvest from 2000–2004; DP: Double Point Counts; A: proportion of Drakes Estero seals using subsite A; Dist: anthropogenic disturbance rate. Rankings are similar if using continuous oyster harvest rather than *categorical*

Age class	Model	Δi	wi	r^2
Pup+Adult	**Oyst+Double Point (DP)**	**0.0**	**0.55**	**0.54**
	Oyst+DP+A	**2.4**	**0.16**	**0.61**
	Oyst+A	**3.9**	**0.08**	**0.42**
	Oyst	4.3	0.06	0.29
	Oyst+Dist	4.5	0.05	0.41
	Oyst+DP+Dist+A	6.1	0.02	0.67
	Oyst+ENSO	6.3	0.02	0.35
	Regional total count	7.9	0.01	0.19
	Year	8.5	0.01	0.17
	DP+Year	9.6	0.00	0.25
	DP	10.4	0.00	0.11


pups + adults (= total seals)
Best models not in Becker 2011
Better models not in Becker 2011
Models from Becker 2011
Weak models not in Becker 2011
Our best model: adj R² = .52
DP pups + total regional seals + 92 protocols
DP seals + total regional seals
DP proportional pups
DP proportional seals
DP pups + total regional pups
DP pups + total regional seals
Becker's best model: adj R² = .29
OYST Hi/Low + DP seals
OYST Hi/Low
OYST annual harvest
P = .0110
P = .0100
P = .0038
P = .0051
P = .0176
P = .0183
P = .051
P = .099
P = .317
adjusted R²
Model ranking
P = < .05
= significant
P = > .05
= not significant
0
0.2
0.4
0.6
0.8
1
0
1
2
3
4
5
6
7
8
9

Ranking of Models in and not in Becker 2011: Proportion Seals in DE

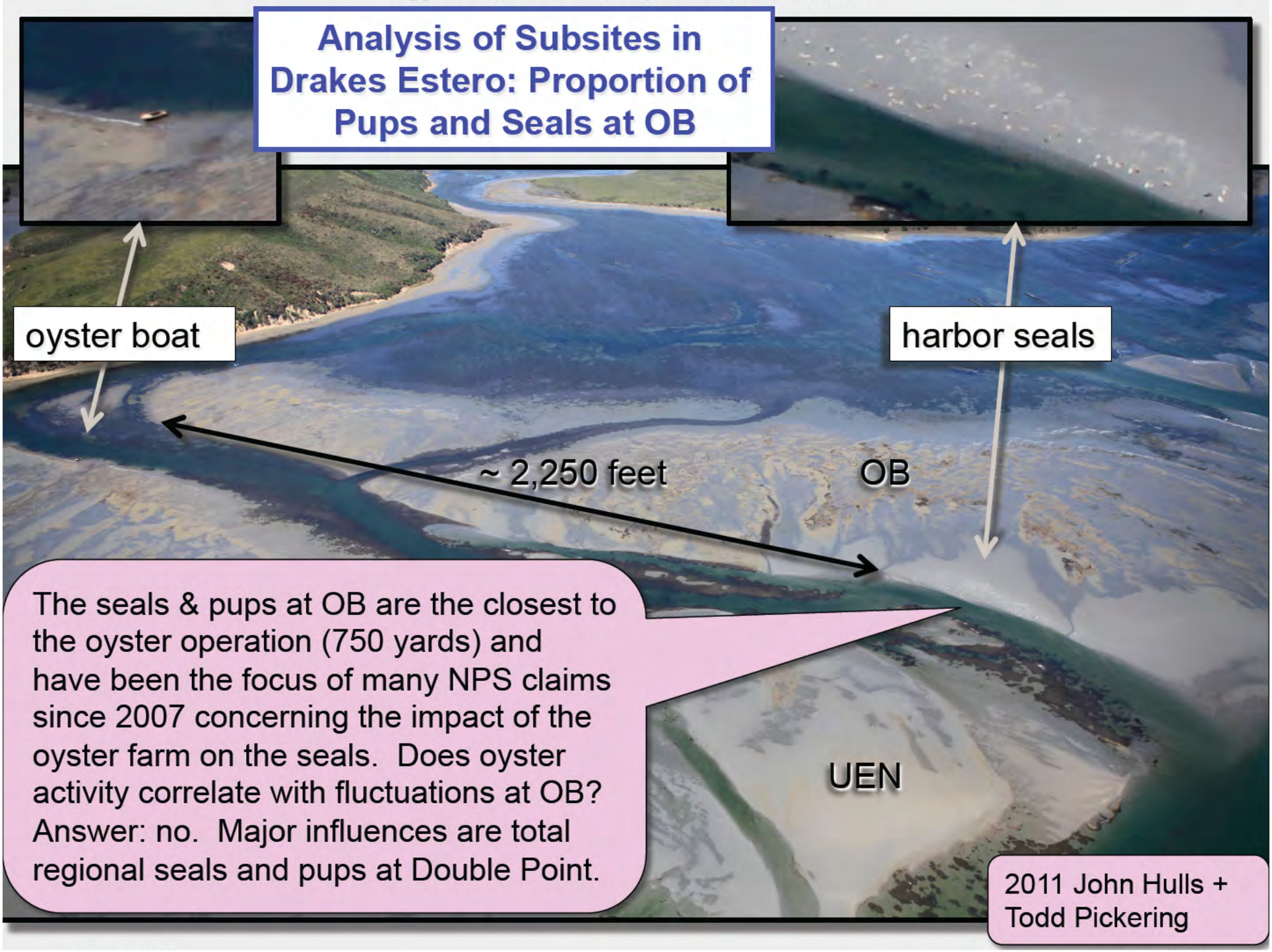
notes	In Becker?	rank	model	P-value	Adj R^2
Best multi-model	no	1	DP pups + total regional seals + 92 protocols	0.011	0.5192
Better multi-model	no	2	DP seals + total regional seals	0.010	0.4585
Best single model	no	3	DP proportional pups	0.004	0.4478
Better single model	no	4	DP proportional seals	0.005	0.4246
Better multi-model	no	5	DP pups + total regional pups	0.017	0.4047
Better multi-model	no	6	DP pups + total regional seals	0.018	0.4011
Becker best multi-model	yes	7	OYST Hi/Low + DP seals (OYST H/L P=.031)	0.051	0.2892
Becker best single model	yes	8	OYST Hi/Low	0.099	0.1331
Weak single model	no	9	OYST annual harvest	0.317	0.0058

The lessons from the analysis of total seals in Drakes Estero is similar to what was learned from the analysis of pups. The best models mostly include total regional seals and some measure of pups or seals at Double Point. As shown in next slide, OYST Hi/Low has no impact on best models. Finally, OYST Hi/Low is driven by 2003 and 2004, whereas best models are robust without those years.

Becker's best model -- OYST Hi/Low – has no impact on top models

notes	rank	model	P-value	Adj R^2
Top multi-model	1	DP pups + total regional seals + 92 protocols	.0110	0.5192
With OYST Hi/Low		DP pups + total regional seals + 92 protocols + OYST Hi/Low	.0267	0.4904
		P-value for OYST Hi/Low = 0.551 (not significant)		
Top single model	3	DP proportional pups	.0038	0.4478
With OYST Hi/Low		DP pups + total regional seals + 92 protocols + OYST Hi/Low	.0146	0.4233
		P-value for OYST Hi/Low = 0.669 (not significant)		

None of our top six models included OYST Hi/Low. When the top multi-model and top single model were run using multi-variant regression analysis and an additional independent variable – OYST Hi/Low – was added, the P-value increased (i.e., significance decreased), the adjusted R^2 either decreased, and the contribution of OYST Hi/Low was not significant. In contrast to the conclusion in Becker et al. 2011, OYST Hi/Low does not have a significant impact on the proportion of seals in Drakes Estero.


Analysis of Subsites in Drakes Estero: Proportion of Pups and Seals at OB
oyster boat
harbor seals
~ 2,250 feet
OB
UEN
The seals & pups at OB are the closest to the oyster operation (750 yards) and have been the focus of many NPS claims since 2007 concerning the impact of the oyster farm on the seals. Does oyster activity correlate with fluctuations at OB? Answer: no. Major influences are total regional seals and pups at Double Point.
2011 John Hulls + Todd Pickering

Ranking of Models: Proportion Pups and Seals at OB

notes	Dependent variable	Independent variables	P-value	Adj R^2
Top model	**OB pups**	**prop.pups.DP + total regional seals**	**0.002**	**0.645**
+ OYST = NS	OB pups	add OYST Hi/Low (P = 0.282, not significant)	0.005	0.655
	OB pups	prop.pups.DP	0.071	0.200
	OB pups	OYST Hi/Low	0.088	0.172
	OB pups	Total regional seals	0.136	0.116
	OB pups	Disturbance rate	0.941	-0.090
Top model	**prop.pups.OB**	**Total regional seals**	**0.001**	**0.583**
	prop.pups.OB	prop.pups.DP	0.087	0.173
	prop.pups.OB	OYST Hi/Low	0.187	0.075
	prop.pups.OB	Disturbance rate	0.754	-0.081

Conclusions concerning pups and seals at OB:

(1) Just as with seals and pups of Drakes Estero, so too the seals and pups at subsite OB, the haul-out site closest to the oyster boats, <u>do not correlate with OYST Hi/Low and do not correlate with the disturbance rate</u>.

(2) Rather the seals and pups at OB <u>do correlate with Mother Nature</u> –total regional seals and in some instances Double Point pups outside Drakes Estero along the PRNS coast.

(3) As mentioned earlier, this relationship to total regional seals was first suggested on Sept 4, 2009 by NAS panel member Dr. Francis O'Beirn.

Ranking of Models: Proportion Pups in Upper Estero (UEN, OB, UEF) (15 year analysis compared to pups in Drakes Estero and pups in region)

notes	model	P-value	Adj R^2
prop.pup.upper estero/ total Drakes Estero pups	Double Point (DP) proportional pups (as a proportion over total regional pups)	0.00862	0.37900
	Total regional seals	0.01052	0.36117
	Disturbance rate	0.58195	- 0.05115
	OYST Hi/Low	0.70276	- 0.06446
	OYST annual harvest	0.94747	- 0.07655
Prop.pup.upper estero/ total regional pups	DP proportional pups (over total regional pups)	0.00032	0.61564
	Total regional seals	0.00121	0.53286
	OYST Hi/Low	0.28304	0.01783
	Disturbance rate	0.63760	- 0.05799
	OYST annual harvest	0.59336	- 0.05266

Conclusions concerning pups at the upper estero sites (UEN, OB, & UEF):

(1) Just as with seals and pups of Drakes Estero, and seals and pups of OB, so too the pups at the upper estero sites (UEN, OB, & UEF) <u>do not correlate with OYST Hi/Low and do not correlate with the disturbance rate</u>.

(2) Rather the pups at the upper estero sites <u>do correlate with Mother Nature</u> – total regional seals and Double Point pups outside Drakes Estero along coast.

Analysis of Becker et al. 2011: conclusions part 1

Evidence for long-term spatial displacement of breeding and pupping harbour seals by shellfish aquaculture over three decades†

BENJAMIN H. BECKER*, DAVID T. PRESS and SARAH G. ALLEN
US National Park Service, Point Reyes National Seashore, Point Reyes Station, CA 94956, USA

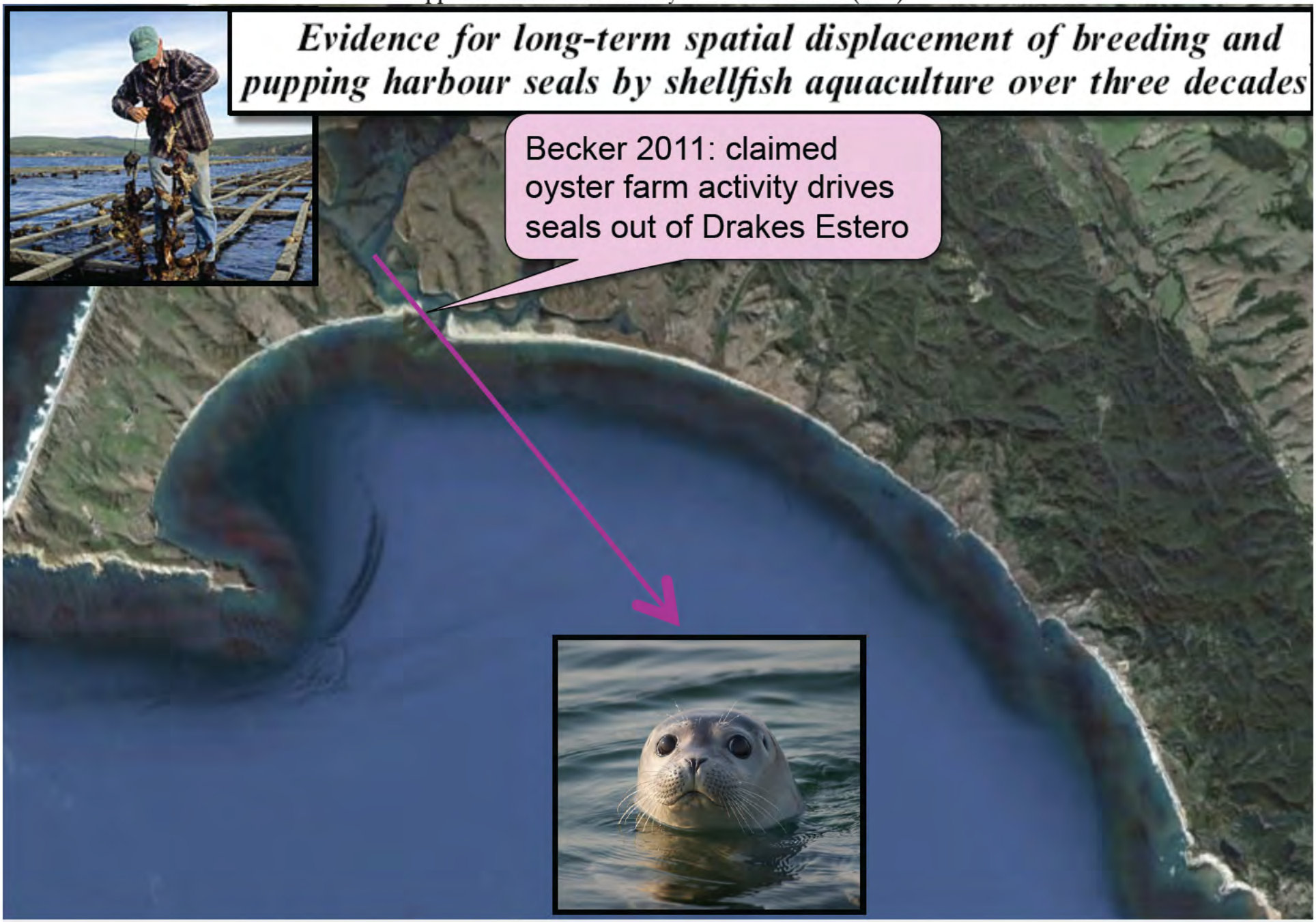
1. Analysis reveals no "*evidence for long-term spatial displacement*"

2. No "*evidence*" that oyster farm displaced seals out of Estero

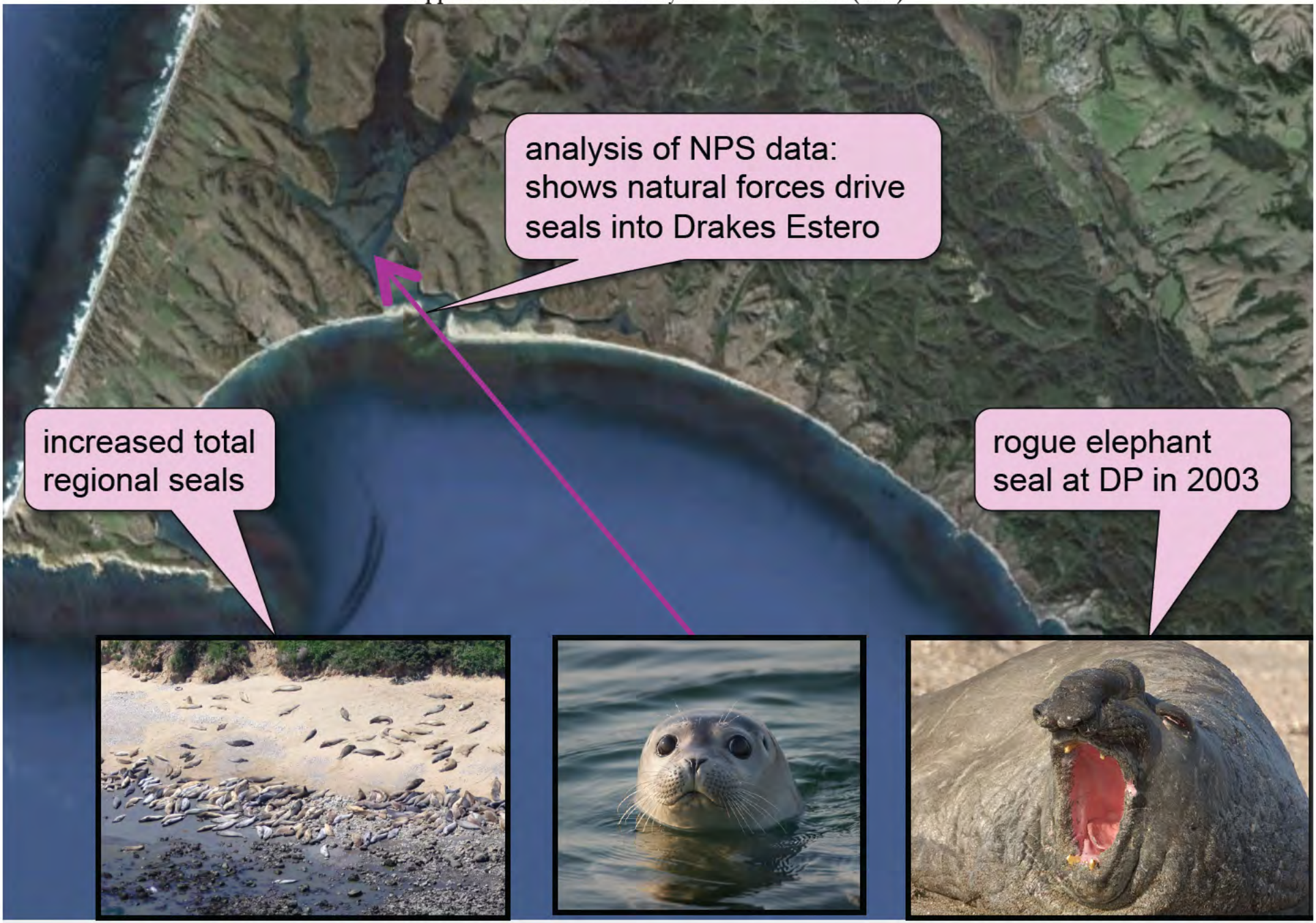
3. Mother Nature leads to movements of seals into & out of Estero
   Major factors: seals at Double Point (DP) & total regional seals

4. Rogue elephant seal at DP in 2003 displaced seals into Estero
   Becker 2011 best models are driven by transient spike in 2003 & 2004

5. Top models using NPS data are far superior to Becker's best model
   Best P-values are 1000 times more significant than in Becker 2011


Evidence for long-term spatial displacement of breeding and pupping harbour seals by shellfish aquaculture over three decades
Becker 2011: claimed oyster farm activity drives seals out of Drakes Estero

59


analysis of NPS data:
shows natural forces drive
seals into Drakes Estero
increased total
regional seals
rogue elephant
seal at DP in 2003

Analysis of Becker et al. 2011: concluding comments

1. Title says "*long-term spatial displacement*" but analysis shows transient; authors failed to note their statistics driven by 2003 & 2004

2. Title says "*evidence*" oyster farm displaced seals but models fail; authors' data generates models 1000 times better than oyster activity

3. Title says "*three decades*" of data but 14 year gap; authors cherry picked 1982 & 1983 data – NPS previously denied these data existed

4. Analysis shows regional harbor seal population, events at Double Point, and elephant seals drive movements of harbor seals into Estero

5. Authors used incorrect seal haul-out maps, incorrect oyster bag maps, and misinterpreted aerial photos; never asked for Lunny data

6. Authors missed opportunity to determine if adaptive management succeeded with 92 (oyster boats) & 96 (kayak) management changes

7. Authors missed opportunity to use data to study biology of harbor seals and population dynamics; authors too focused on oyster farm

Analysis of Becker, Press, and Allen 2011
Part 2: Maps, Claims, and Inferences

Corey S. Goodman, PhD

Analysis of Becker et al. 2011: conclusions part 2

Evidence for long-term spatial displacement of breeding and pupping harbour seals by shellfish aquaculture over three decades†

BENJAMIN H. BECKER*, DAVID T. PRESS and SARAH G. ALLEN
US National Park Service, Point Reyes National Seashore, Point Reyes Station, CA 94956, USA

1. Annual oyster harvest is not surrogate for UEN/OB pupping season

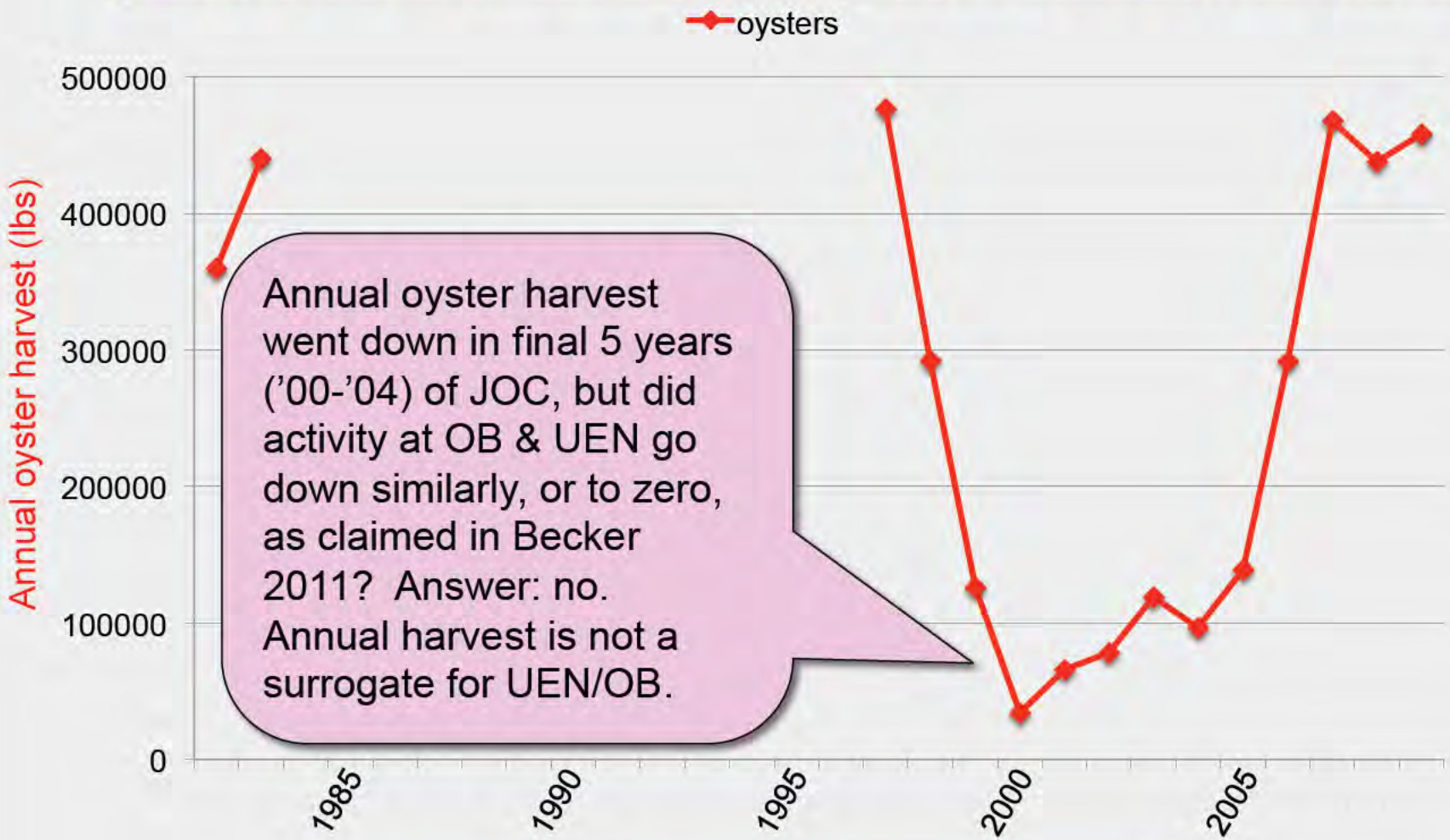
2. Seal haul-out map is misleading: seals and oysters do not overlap

3. Claims and maps of oyster bags in pupping areas are incorrect

4. Claims of zero oyster bags at OB/UEN from 2000-2004 are incorrect
CDPH records show JOC continued to harvest from UEN & OB

5. Inferences that drove OYST Hi/Low categorical model are incorrect
NPS did not provide conclusive data to support major model in paper

Is annual oyster harvest a surrogate for oyster activity at OB/UEN during pupping season? A: No



annual oyster harvest

Quotes from NAS/NRC panel report, May 5, 2009

"More generally, the use of annual oyster harvest as a proxy for disturbance rate at the haul-out subsites relies on the assumption that mariculture methods and daily activities have not changed over the 11 years that were analyzed. Some potentially confounding factors include changes in the fraction of the harvest from oysters cultivated using the rack system (mostly more distant from the haul-out sites) and the fraction cultivated in bags placed on sand bars also used by seals as haul-out sites."

"… the use of oyster production level as a proxy for mariculture activities that displace or disturb seals may be confounded by changes in culture methods or management practices."

"For these reasons, the Becker et al. (2009) paper has limited value for understanding the long-term trends in seal counts in Drakes Estero."

Quotes from MMC panel meeting, February 23, 2010

Kevin Lunny:
"I of course have given it a lot of thought, because Becker I, II, and III are all based on annual production rates. I think this really points to a core issue that's behind this whole discussion. The core issue is communication. The core issue is working together so we understand how these things might affect the marine mammals. We have lots of different influences, really the single one that was focused on was production for the Becker et al papers. We were never contacted and so we've never had any input, we've never had a part, we've never had a seat at the table. We've never been asked a single question. And those data are all available."

Lunny offered his data on February 23, 2010. Becker, Press, and Allen submitted their paper on October 14, 2010. Between those two dates, Becker never asked Lunny for the DBOC data.

Quotes from MMC panel meeting, February 23, 2010

Ben Becker:

"I fully agree with Kevin that it would be great if we had better measurements, right time period, and all this other stuff. But we also need to think about, we need a dataset that we can go all the way back to '97, or '82 in the case of the new analysis, that is consistent. Sometimes there's a trade-off between accuracy and consistency."

Gordon Bennett:

"… what strikes me is that the information that's been revealed that exists today is really important and could have really informed Ben's papers. We're only hearing it revealed today, for the last over a year we've heard criticisms of the use of the annual production harvest number, but only criticisms, without knowing that the helpful information is actually there and could be used. …Ben could've used that information. This is great."

Quotes from MMC panel meeting, February 23, 2010

Kevin Lunny:
"Just a quick response to what Gordon said, that we somehow haven't shared those data. That sounds like there's an assumption that we knew Becker was working on another new report. We would have loved to collaborate."

Gordon Bennett:
"I just wanted to point out that I believe it's in Kevin's own best interest to provide this information. Because if we don't get better clarity on this issue, then the only information we have is the annual harvest, and that seems to imply a causation factor. So it would be, I would say, worthwhile Kevin's effort, even though it admittedly is an effort, to provide additional information if it could illuminate this process better. Maybe it would come out to the same result, we don't know. But the result now as it appears from Ben's paper is that there is a strong correlation."

DBOC data on oyster harvest & harvest boat trips to UEN/OB during pupping season March-May

DBOC Harvests - Barries Bar (nearest to OB and UEN - Harvest Areas 14,15,16,17,20 and 42)

	2003 (JOC)		2004 (JOC)		2005		2006		2007		2008		2009		2010	
	Harvest Area	Quantity	Harvest Area	Quantity	Harvest Area	Quantity	Harvest Area	Quantity	Harvest Area	Quantity	Harvest Area	Quantity	Harvest Area	Quantity	Harvest Area	Quantity
1-Mar					17	120					20	20				
2-Mar					17	110	17	40			14	140			17	50
3-Mar							17	60							17	60
4-Mar													20	50	17	60
5-Mar															17	50
6-Mar													20	60		
7-Mar							17	60					20	40		
8-Mar							17	20								
9-Mar							17	100								
10-Mar													20	20		
11-Mar											15	40	20	60	15	30
12-Mar															15	60
13-Mar													20	30		
14-Mar																
15-Mar																
16-Mar																
17-Mar													20	50		
18-Mar											15	30			15	60
19-Mar													20	40	20	140
20-Mar													20	40		
21-Mar													20	30		
22-Mar					17	80									15	60
23-Mar					17	30									15	30
24-Mar					17	120	20	60	20	160			15	40	15	20
25-Mar															15	40
26-Mar															15	30
27-Mar							20	200			15	40	20	50	15 and 20	70
28-Mar							20	160								
29-Mar					15	120										
30-Mar					17	180			20	20						
31-Mar													20	50		
1-Apr															15	50
2-Apr													20	40	15	15
3-Apr											17	160	20	60	15	60
4-Apr							20	20					20	50		
5-Apr																
6-Apr							20	40								
7-Apr							20	15					20	30		
8-Apr															15	30
9-Apr							20	20							15	40
10-Apr															15	40
11-Apr																
12-Apr							17	27								
13-Apr							17	120							17	50
14-Apr							17	60			14	160	20	25		
15-Apr							17	60					17	110	15	30
16-Apr															15	40
17-Apr							20	14					15	40	15	40
18-Apr													20	160		
19-Apr																
20-Apr															15	20
21-Apr													15	30		
22-Apr							20	20							15	40
23-Apr													15	40	20	30
24-Apr													15	60	15	20
25-Apr							20	18					15	10		
26-Apr											15	60				
27-Apr							20	20							15	20
28-Apr													15	50	15	20
29-Apr							20	15			15	40			15	50
30-Apr													15	30	15 and 20	60
1-May											15	50	20	70	15	50
2-May											15	60				
3-May							20	60			20	70				
4-May															15	40
5-May													15	30	15	40
6-May																
7-May													15	30	15	40
8-May													15	40	15	30
9-May																
10-May							20	50								
11-May					17	30									15	40
12-May							20	30					15	30	15	200
13-May							20	50			15	20	20	160		
14-May											20	160	20	240	15 and 20	90
15-May													20	200		
16-May							20	60			20	60	20	120		
17-May																
18-May							20	20								
19-May													10	30		
20-May					17	160					15	30	15	60	15	40
21-May													15	40		
22-May													20	40	20	30
23-May													20	100		
24-May							20	160								
25-May							20	40							15	60
26-May							20	20					15	20	15	50
27-May							20	20								
28-May							20	30					15	100	20	70
29-May							20	30					15	30	15	60
30-May																
31-May																

Oyster harvest boat trips during pupping season (March – May). Only two trips took place during pupping season in 2007 on March 24 and 30. The next oyster harvest trip to the west end of the lateral channel was not until August 7. The number of UEN/OB oyster harvest boat trips was highest in 2006, 2009, and 2010. Note oyster harvest from bed #17 (UEN) in 2005 (this is relevant for slide #40).

Annual oyster harvest is not a surrogate for oyster activity at UEN/OB during pupping season

year	Annual oyster harvest (lbs)	UEN/OB Mar-May oyster harvest	UEN/OB Mar-May boat harvest trips
2005	138958	8160	9
2006	291538	15184	33
2007	468000	1440	2
2008	438000	9080	16
2009	458000	22280	44

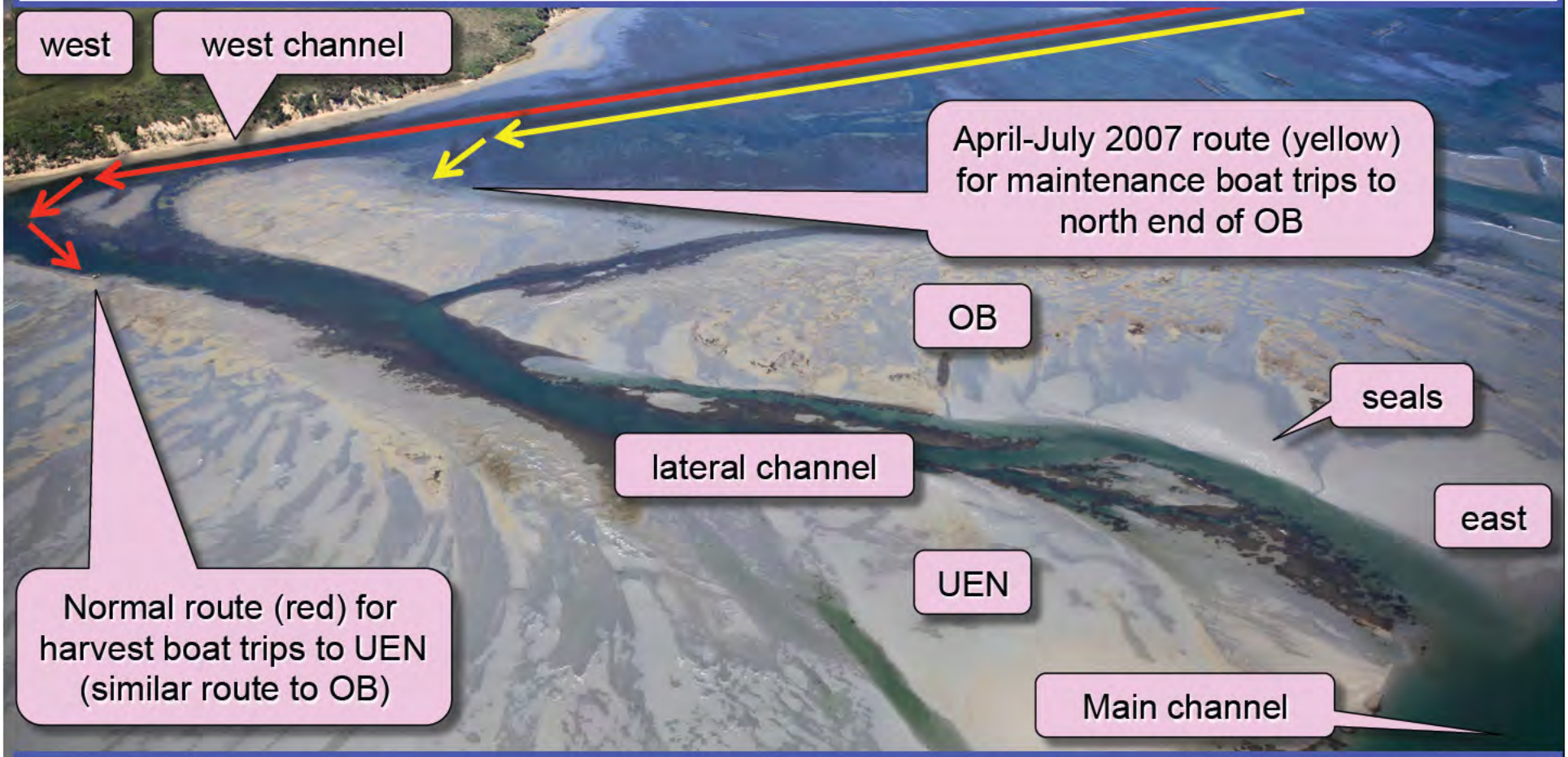
In April '07, DBOC stopped harvesting at UEN/OB until August (details on next page)

model	P-value	Adj R^2
UEN/OB Mar-May oyster harvest vs. UEN/OB Mar-May harvest boat trips	0.005	0.984
Annual oyster harvest vs. UEN/OB Mar-May boat harvest trips	0.650	- 0.317
Annual oyster harvest vs. UEN/OB Mar-May oyster harvest (lbs)	0.737	- 0.396

The data are clear – there is no relationship between annual oyster harvest vs. activity at UEN/OB during pupping season.

UEN/OB pupping season (Mar-May) harvest & harvest boat trip data have been collected by DBOC since 2005. The Marine Mammal Commission encouraged Becker in Feb 2010 to obtain these data, but he did not.

In early April 2007, after Superintendent Neubacher told Supervisor Kinsey that NPS had overwhelming data that DBOC was disturbing the harbor seals and was considering criminal charges, Lunny told Jorge Mata to stop entering the west end of lateral channel and stop accessing UEN during pupping season



DBOC workers made two harvest trips to bed #20 (OB) on March 24 & 30, 2007 and did not go back to the lateral channel to harvest from bed #20 (OB) until August 7. In the intervening months, DBOC workers report having made a few maintenance trips to north end of OB but did not enter the lateral channel.

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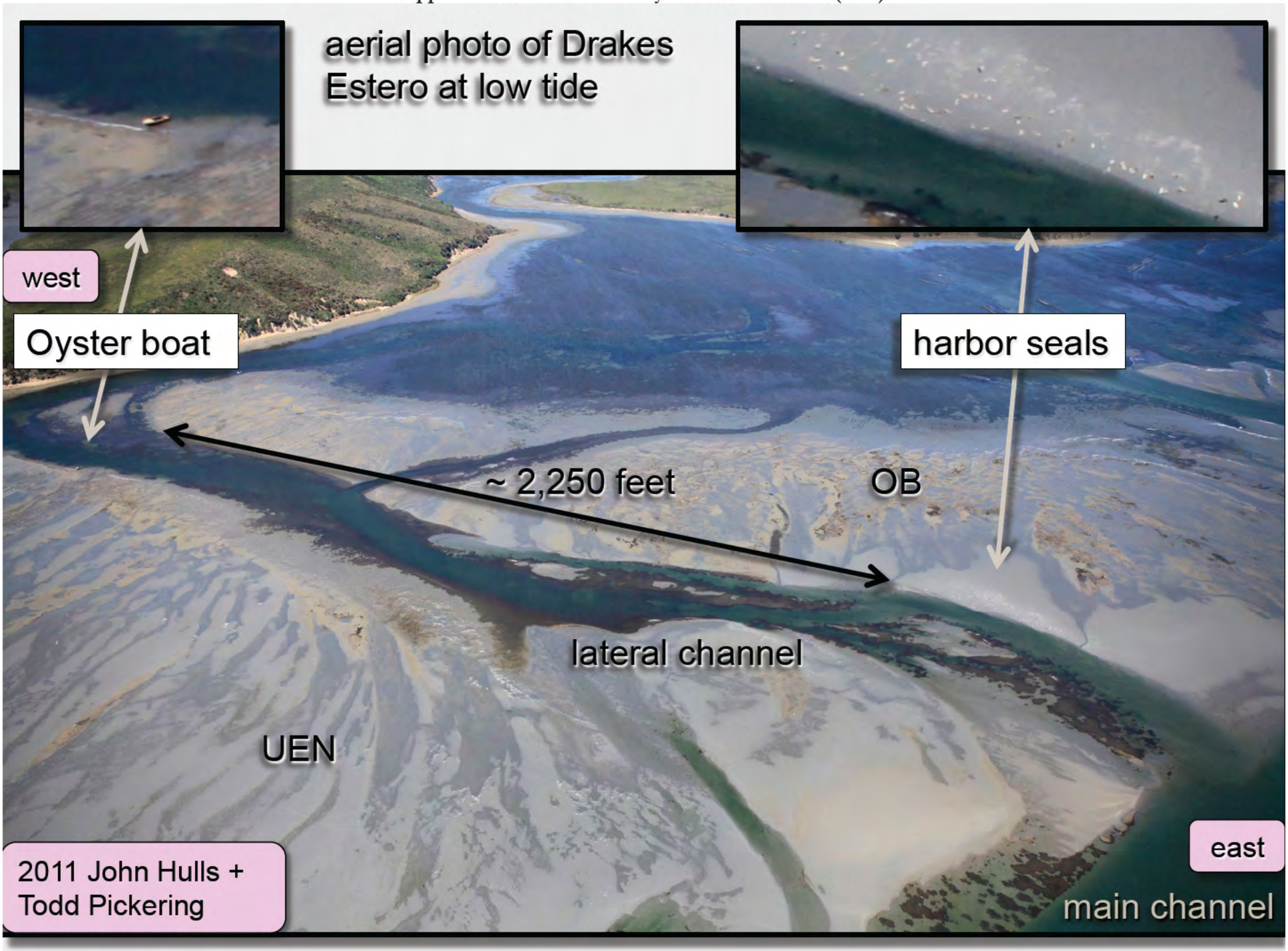

aerial photo of Drakes Estero at low tide
west
Oyster boat
harbor seals
~ 2,250 feet
OB
lateral channel
UEN
2011 John Hulls + Todd Pickering
east
main channel

Quotes from MMC panel meeting, February 23, 2010

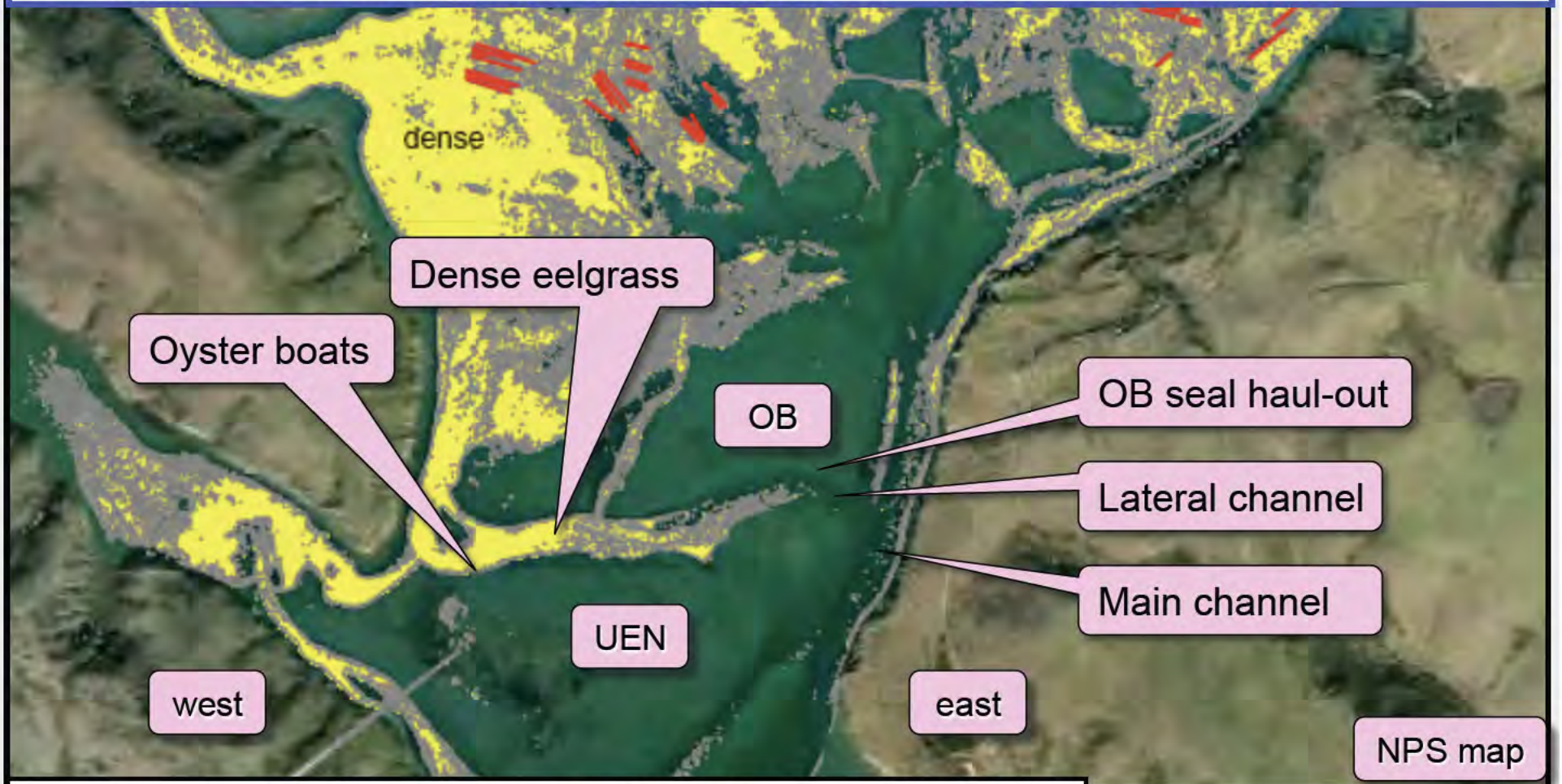
Dr. Sarah Allen: *"… in fact, they* [the harbor seals] *used to go up into Barries Bay when that channel was deeper. That channel* [i.e., the lateral channel] *has narrowed so they can't access it. But there aren't high enough sandbars and deep enough channels other than the ones they're using."*

Kevin Lunny: *"Sarah's exactly correct, the lateral channel used to be deeper and it gave the harbor seals access to Barries Bay. And that has since completely closed off. The lateral channel is far shallower now. You'll look at the eelgrass maps and you'll see that in the past decade or so, eelgrass has filled in the lateral channel and we don't see the harbor seals hauling out along the lateral channel now. You know, the concern is that because of the shellfish aquaculture, or not, I just wanted to bring that out, because that has dynamically changed and shut off that access at the end of the lateral channel into Barries Bay. … as we saw yesterday on the tour, it's very very shallow."*

Sarah Allen: *"I concur with what Kevin's noted about changes to the lateral channel, but the seals are still using the lateral channel to that one little side channel that cuts across the north top. …I agree, there is eelgrass there and certainly some morphological changes."*

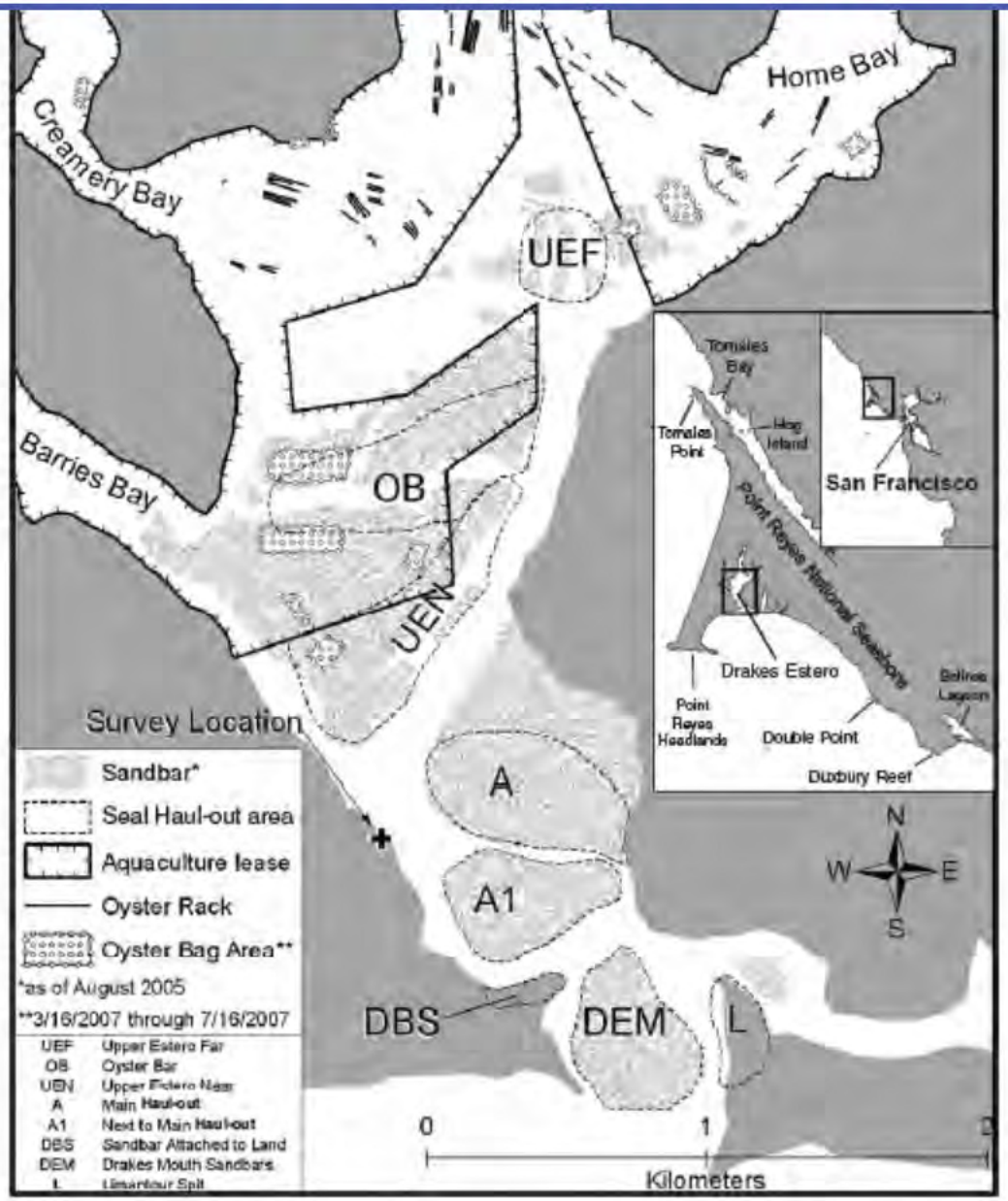
Kevin Lunny: *"… You'll look at the eelgrass maps and you'll see that in the past decade or so, eelgrass has filled in the lateral channel and we don't see the harbor seals hauling out along the lateral channel now."*

Sarah Allen: *"I concur with what Kevin's noted about changes to the lateral channel … I agree, there is eelgrass there …"*



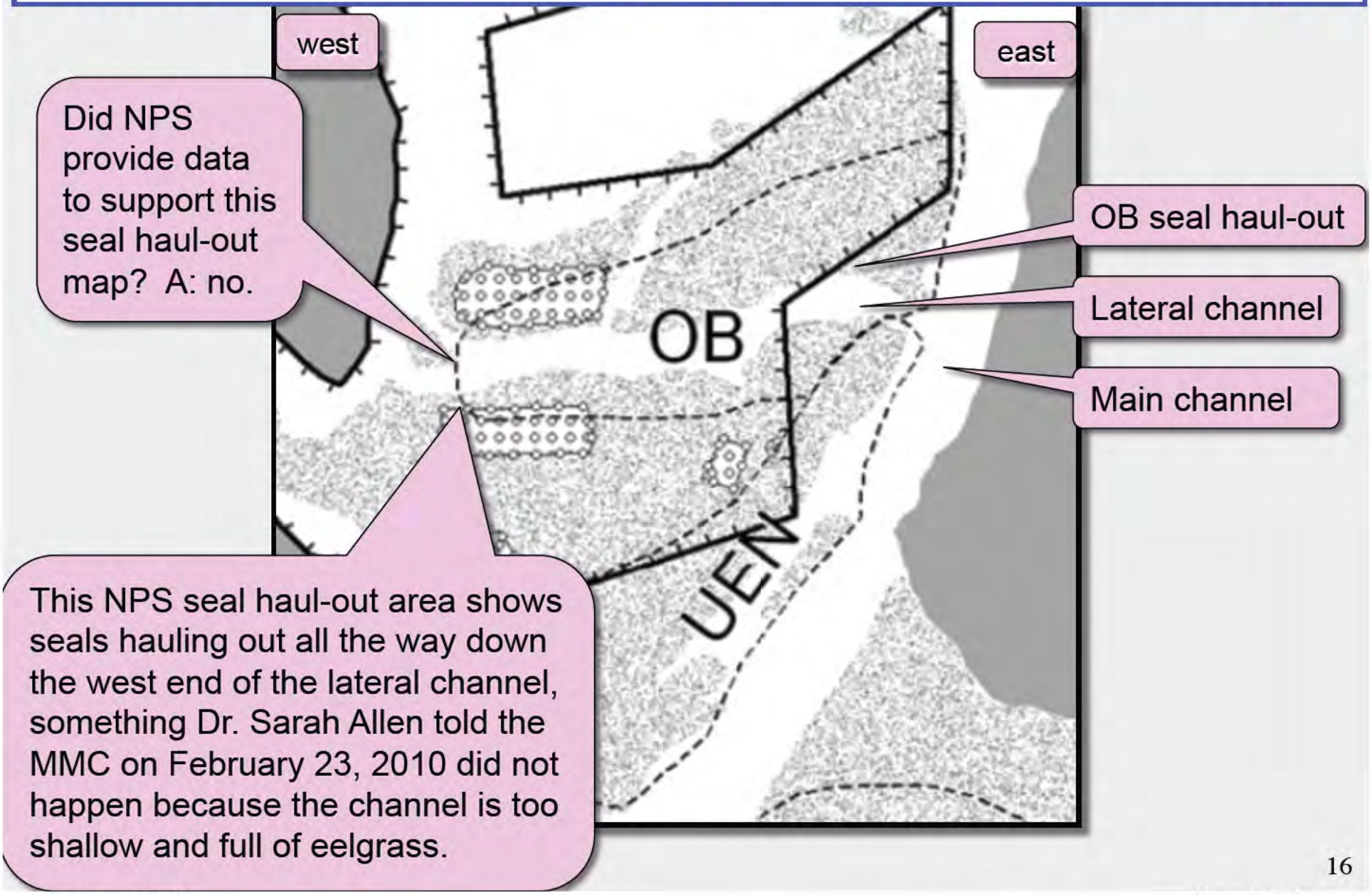
Drakes Estero Eelgrass Density Classifications NPS 2007

Becker's Figure 1 gave false impression that oyster bags are within seal haul-outs – map is inaccurate and misleading

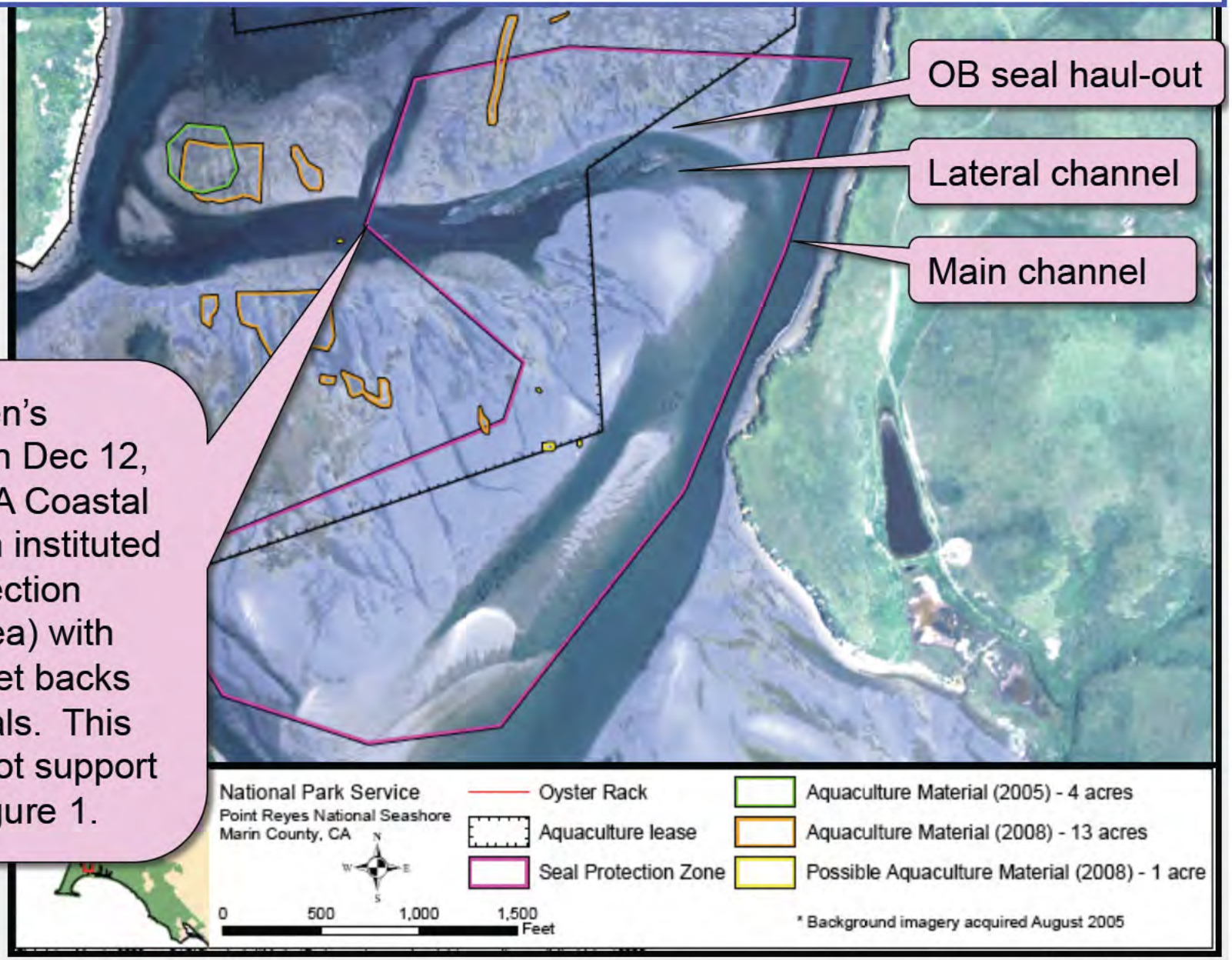


15

Becker's Figure 1 gave false impression that oyster bags are within seal haul-outs – map is inaccurate and misleading

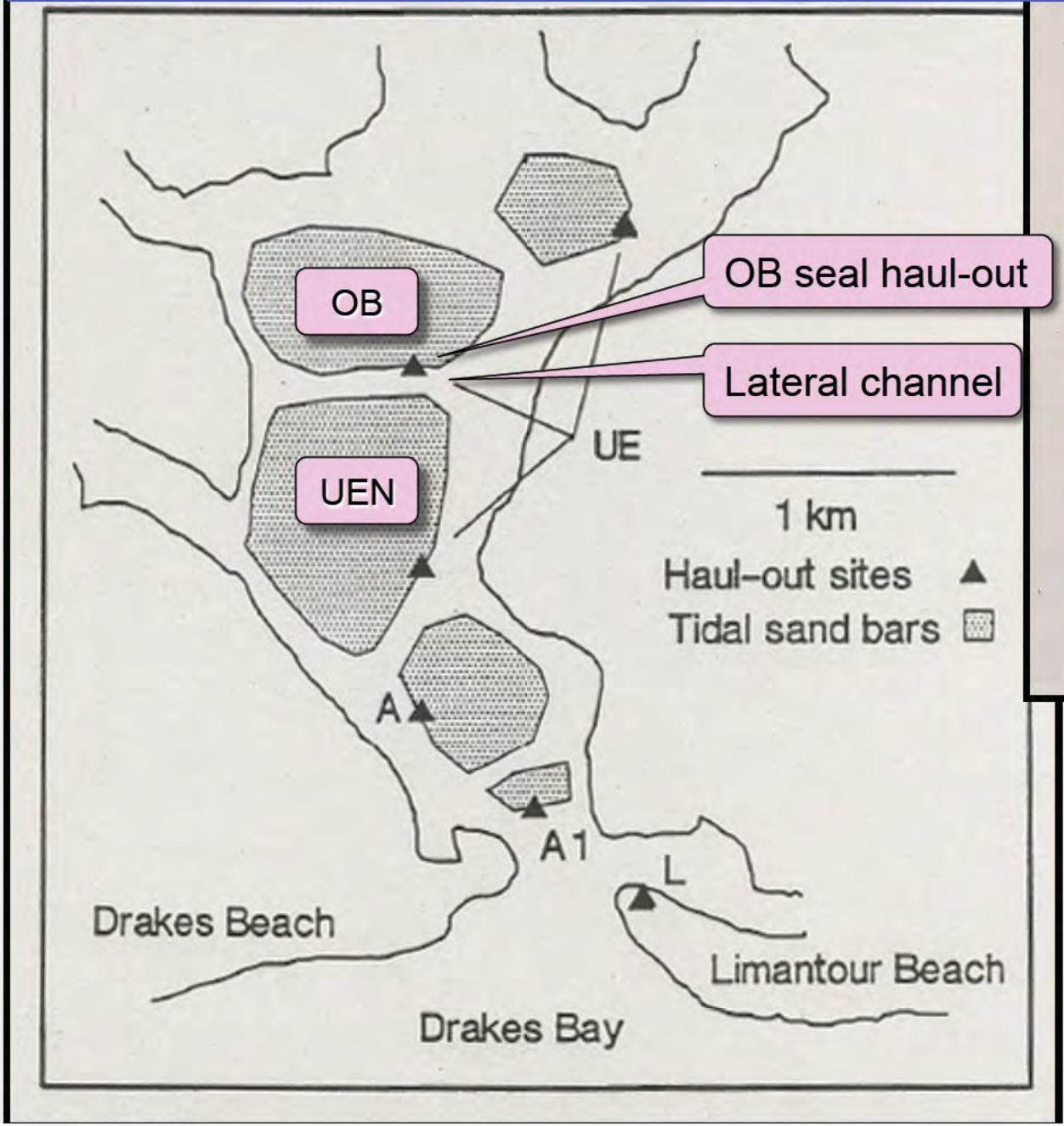


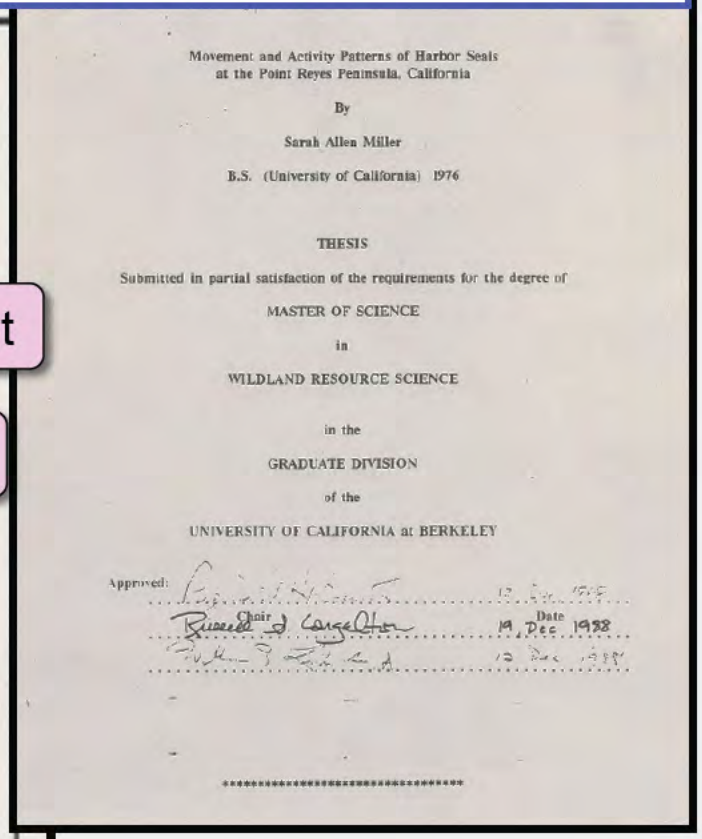
Becker's Figure 1 gave false impression that oyster bags are within seal haul-outs – map is inaccurate and misleading



With Dr. Allen's guidance, on Dec 12, 2007, the CA Coastal Commission instituted a Seal Protection Zone (or Area) with significant set backs from the seals. This map does not support Becker's Figure 1.

Harbor seal haul-out sites from Sarah Allen's thesis in 1988





Movement and Activity Patterns of Harbor Seals
at the Point Reyes Peninsula, California

By

Sarah Allen Miller

B.S. (University of California) 1976

THESIS

Submitted in partial satisfaction of the requirements for the degree of

MASTER OF SCIENCE

in

WILDLAND RESOURCE SCIENCE

in the

GRADUATE DIVISION

of the

UNIVERSITY OF CALIFORNIA at BERKELEY

Approved:

Chair Date 19 Dec 1988

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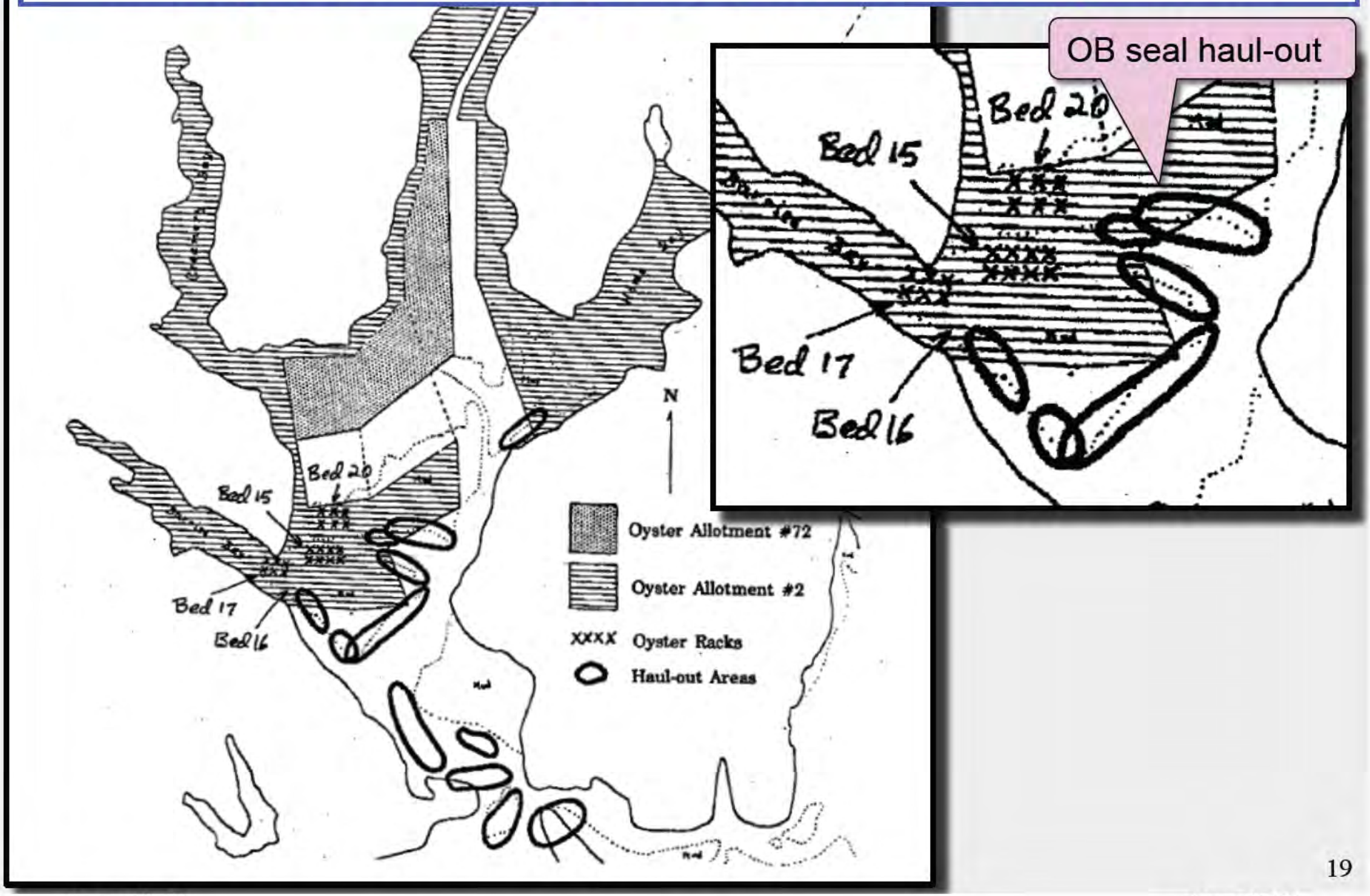
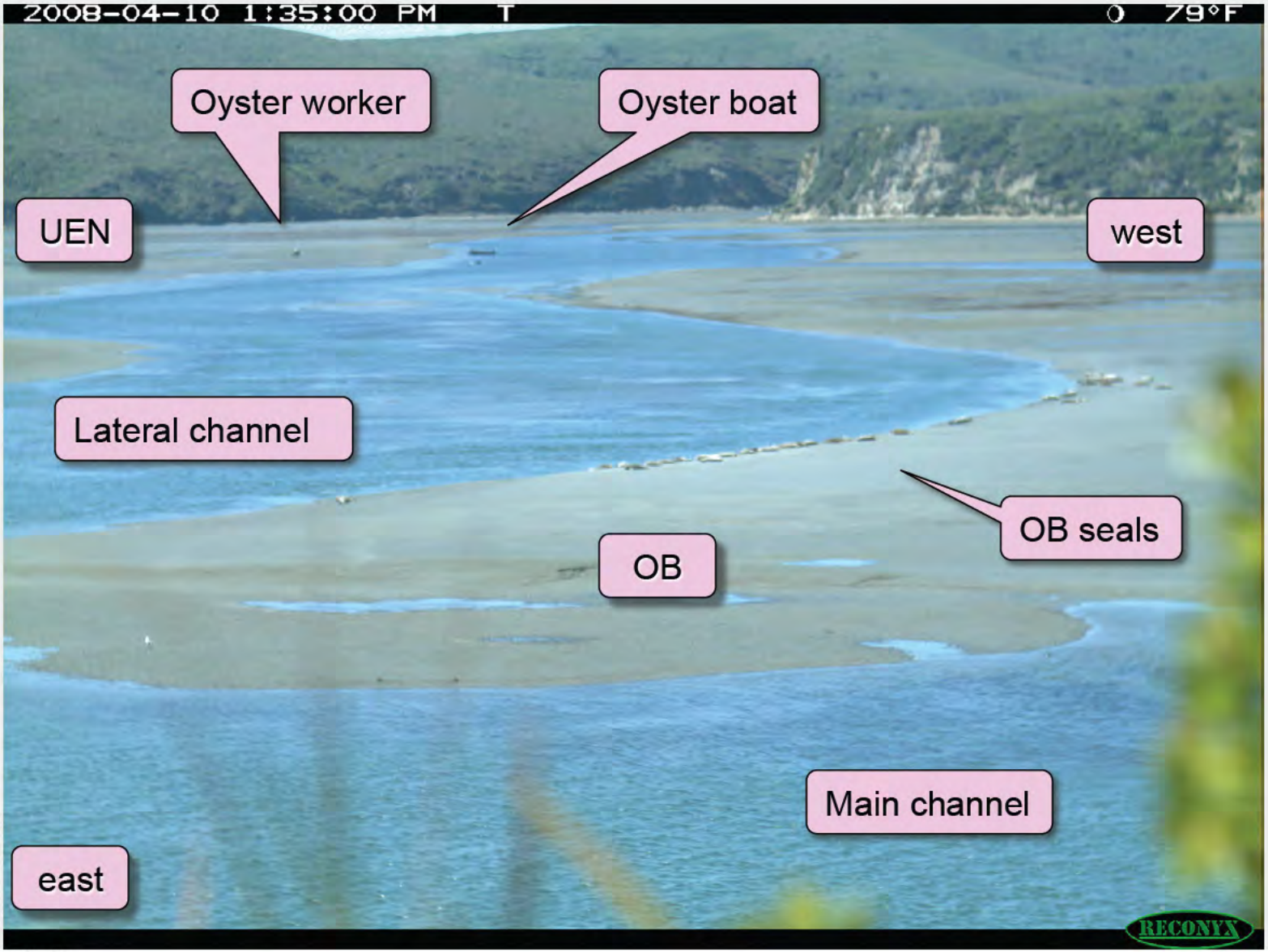
Harbor seal haul-out areas map used by Tom Moore (CDFG) on May 20,1991, and by 1992 Federal-State agreement



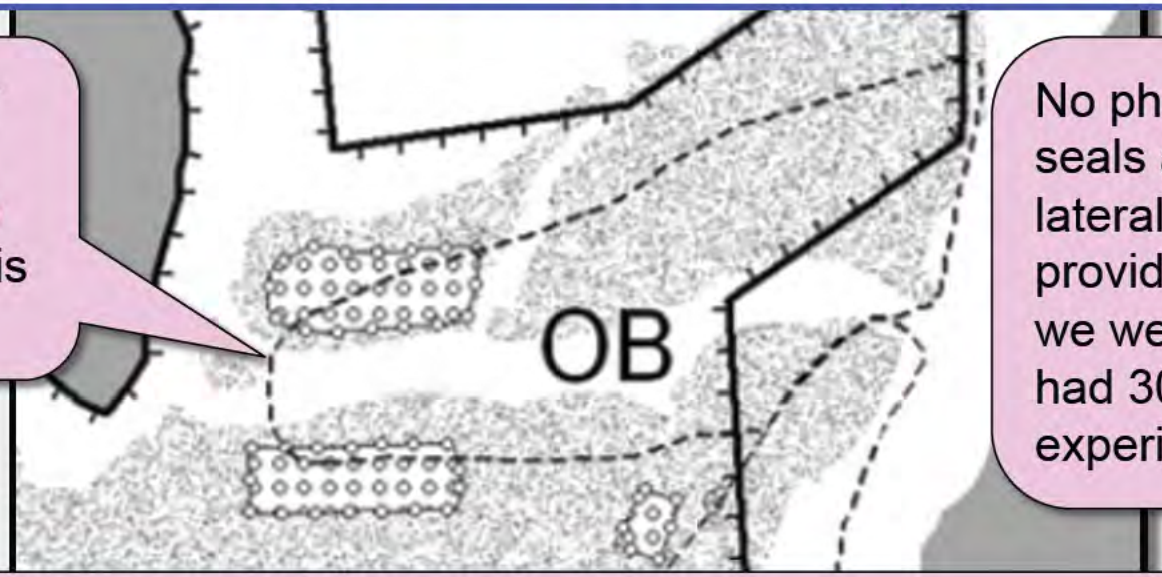
281,000 photographs from NPS secret cameras ('07-'10) show OB seals at east end of lateral channel, and oyster boats and workers at west end, well over 600 yards away



20

Figure 1 in Becker 2011 gives false impression that oyster bags are within seal haul-outs – map is inaccurate

We asked for data (i.e. photographs) supporting this boundary.



No photographs of seals at west end of lateral channel were provided. Rather, we were told authors had 30 years of experience.

We asked Dr. Becker:

"Please provide the aerial photographs and other documents, and data that were used to derive the "seal haul-out area" line drawn in Figure 1. If any of the data used to derive the "seal haul-out area" line drawn on Figure 1 is a decade or older, provide photographs showing the extent of eelgrass coverage of the lateral channel at that time."

Dr. Becker responded:

"Layer created by Author's personal experience over 30 years and writing several reports on harbor seals in Drakes Estero. Some additional DFG and NOAA reports on MMC website include maps of haul out areas."

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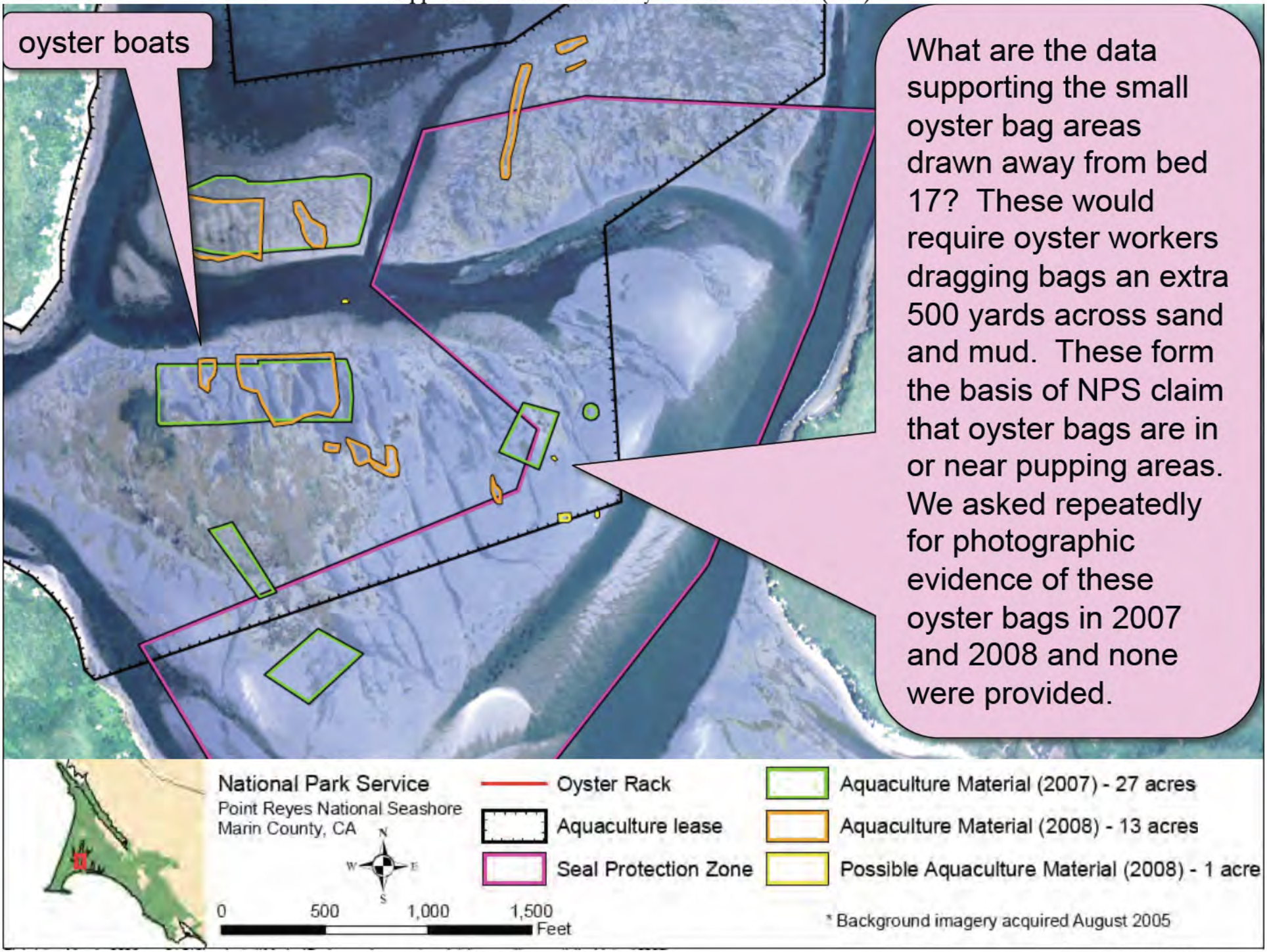
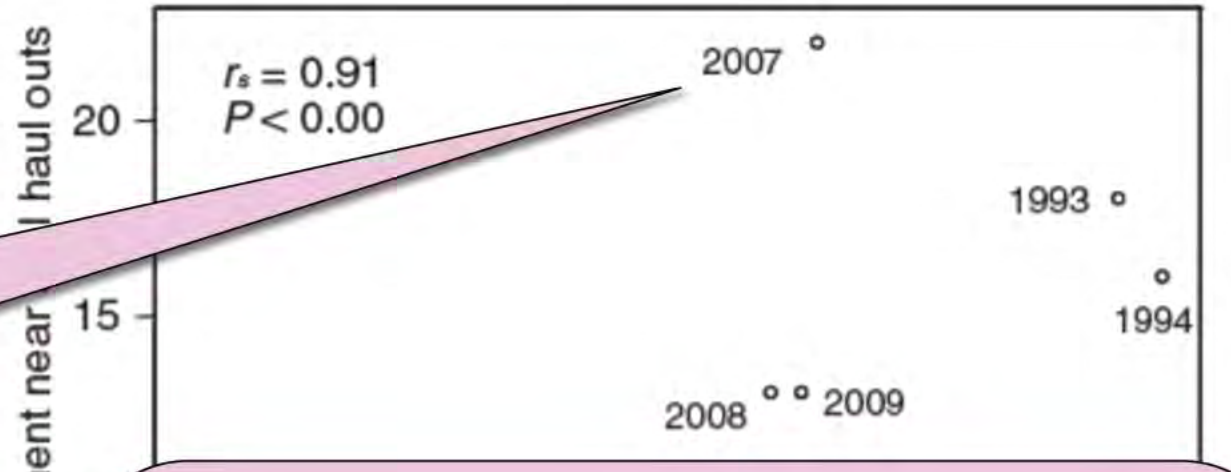

oyster boats
What are the data supporting the small oyster bag areas drawn away from bed 17? These would require oyster workers dragging bags an extra 500 yards across sand and mud. These form the basis of NPS claim that oyster bags are in or near pupping areas. We asked repeatedly for photographic evidence of these oyster bags in 2007 and 2008 and none were provided.
National Park Service
Point Reyes National Seashore
Marin County, CA
N
W
E
S
0
500
1,000
1,500
Feet
Oyster Rack
Aquaculture lease
Seal Protection Zone
Aquaculture Material (2007) - 27 acres
Aquaculture Material (2008) - 13 acres
Possible Aquaculture Material (2008) - 1 acre
* Background imagery acquired August 2005



Becker 2011 claimed 22 acres of oyster bags in 2007.

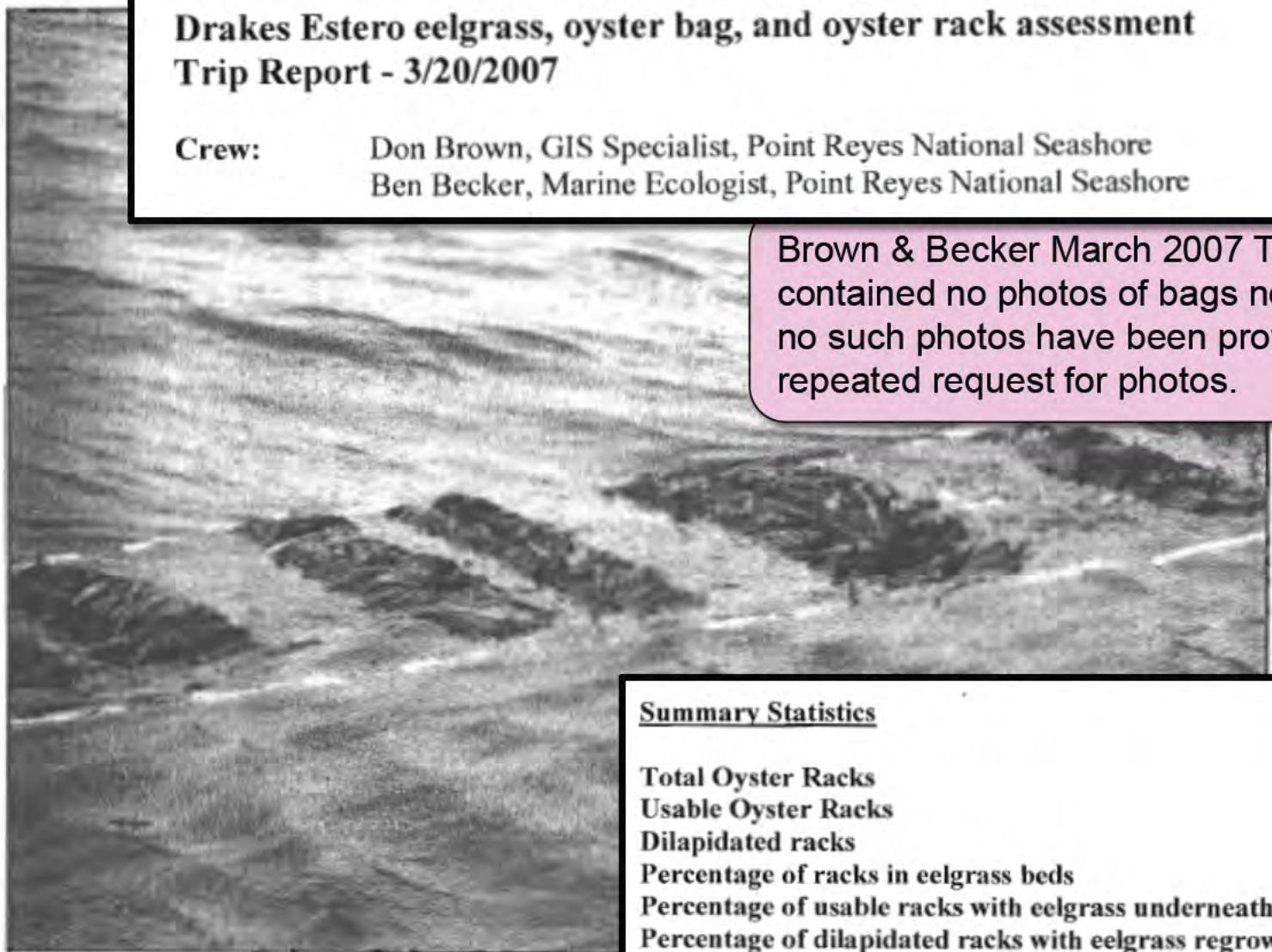
Becker 2011 claimed these data came from aerial photos. When we repeatedly asked Becker for the 2007 photos, he finally acknowledged that the data came from "*on the ground GPS*." The "*on the ground GPS*" came from the Don Brown and Ben Becker Trip Report of 3/13/2007. However, that Trip Report measured 10 acres, not 22 acres, was done at a high tide when many oyster bags were floating or under water, and admitted that "*some site areas estimated from a distance*."

Figure 4. Relationship between annual oyster harvest and the acreage of oyster equipment near (<300 m) or adjacent to seal haul-out sites.

Drakes Estero eelgrass, oyster bag, and oyster rack assessment
Trip Report - 3/20/2007

Crew: Don Brown, GIS Specialist, Point Reyes National Seashore
Ben Becker, Marine Ecologist, Point Reyes National Seashore

Brown & Becker March 2007 Trip Report contained no photos of bags near pupping areas; no such photos have been provided by NPS after repeated request for photos.

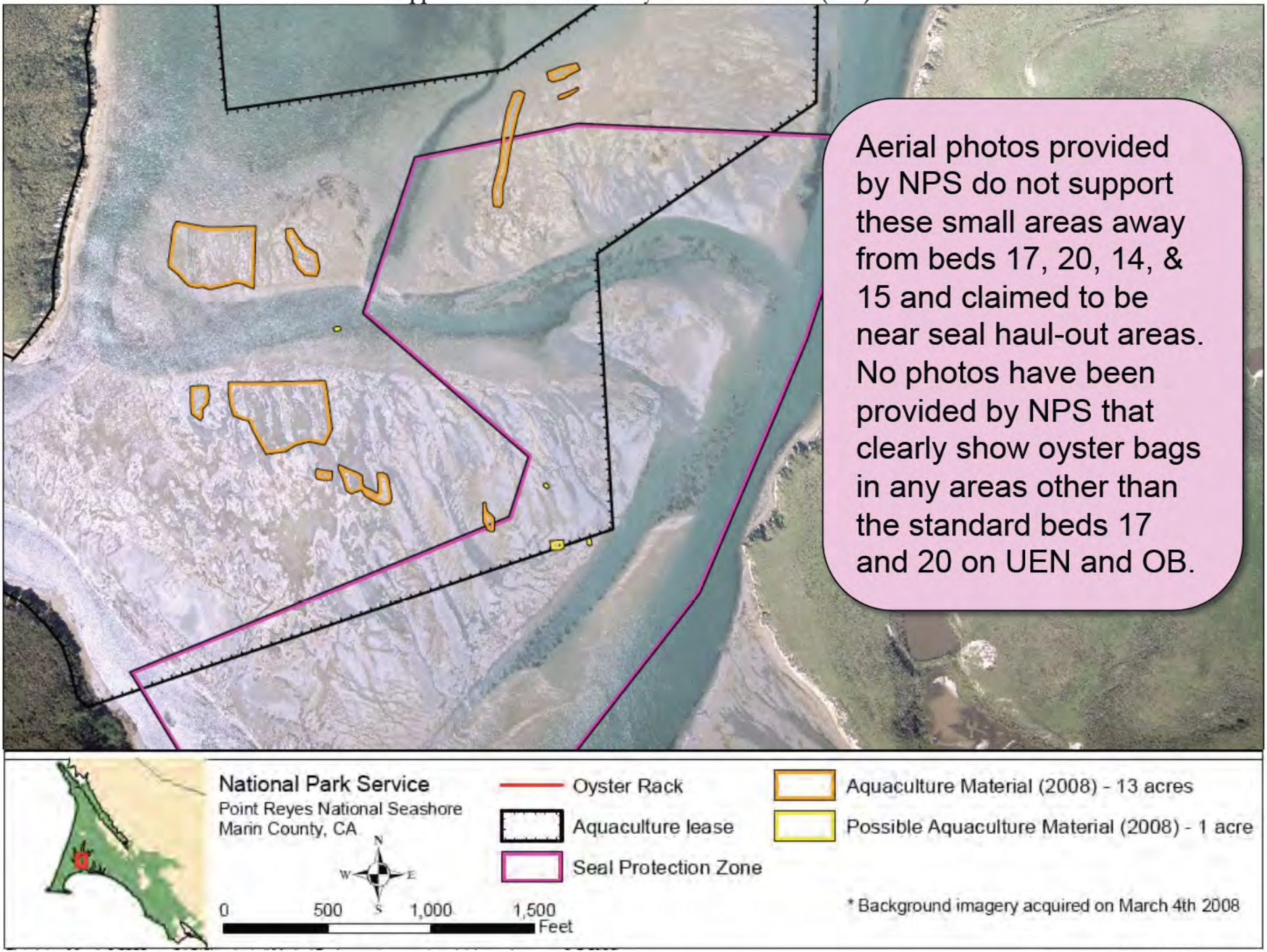


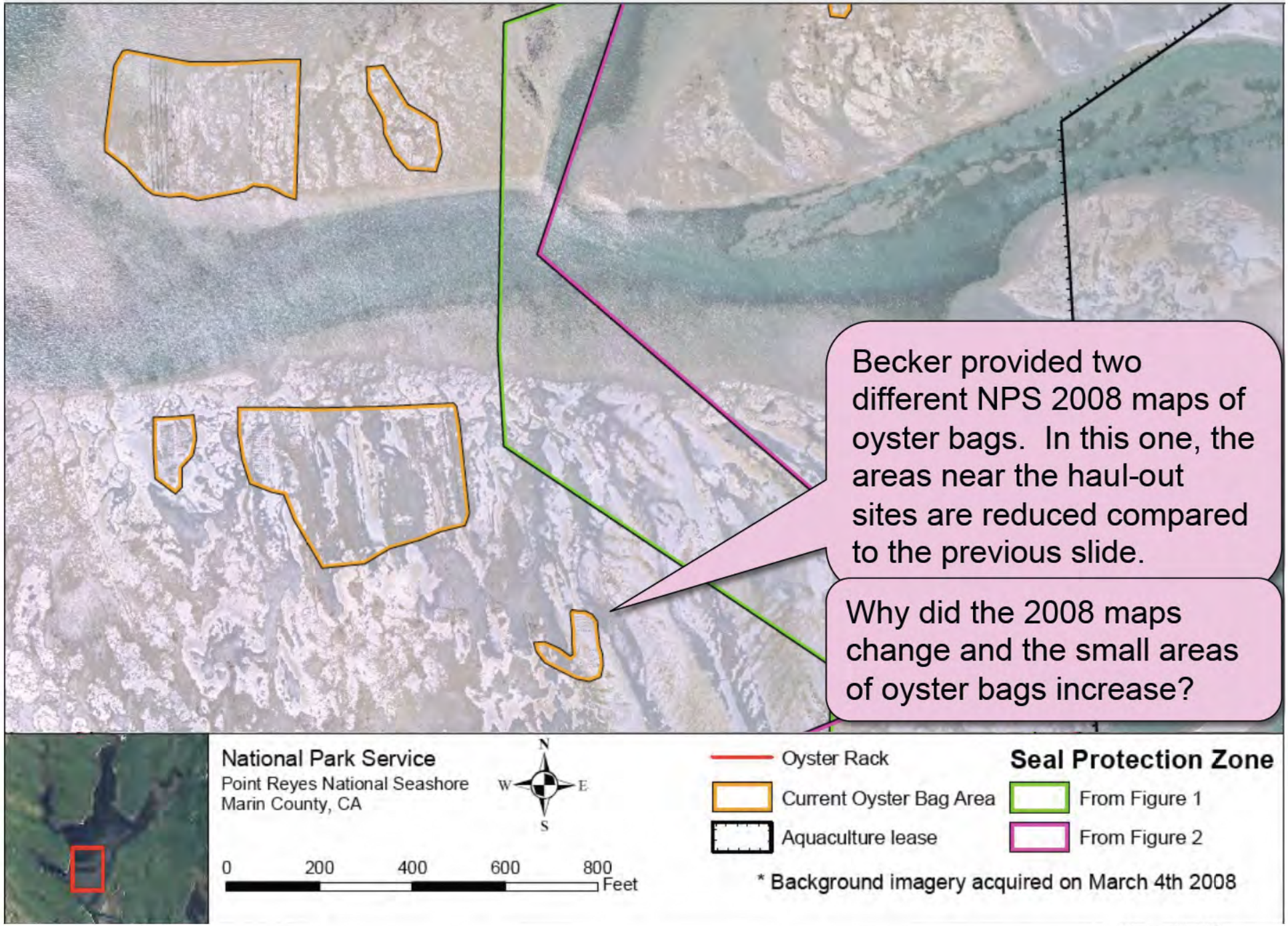
Floating bag system tethered by ropes.

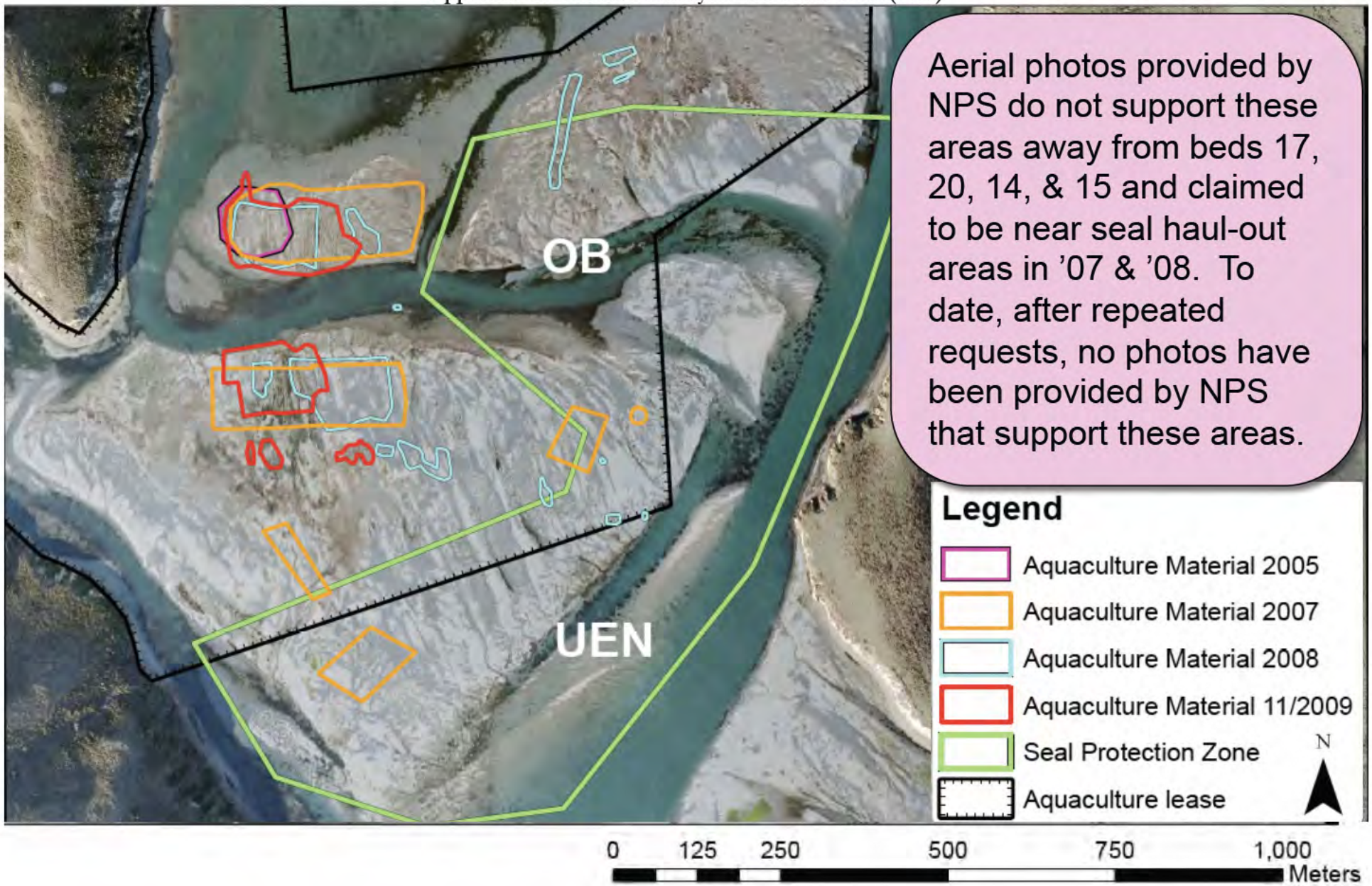
Summary Statistics

Total Oyster Racks	93
Usable Oyster Racks	66
Dilapidated racks	27
Percentage of racks in eelgrass beds	96% (89 of 93)
Percentage of usable racks with eelgrass underneath	0%
Percentage of dilapidated racks with eelgrass regrowth	26% (7 of 27)
Acres of eelgrass lost to racks	8 acres
Number of intertidal oyster bag areas	12
Acreage of intertidal oyster bag sites	10 acres
Total eelgrass acreage in the Estero	740 acres

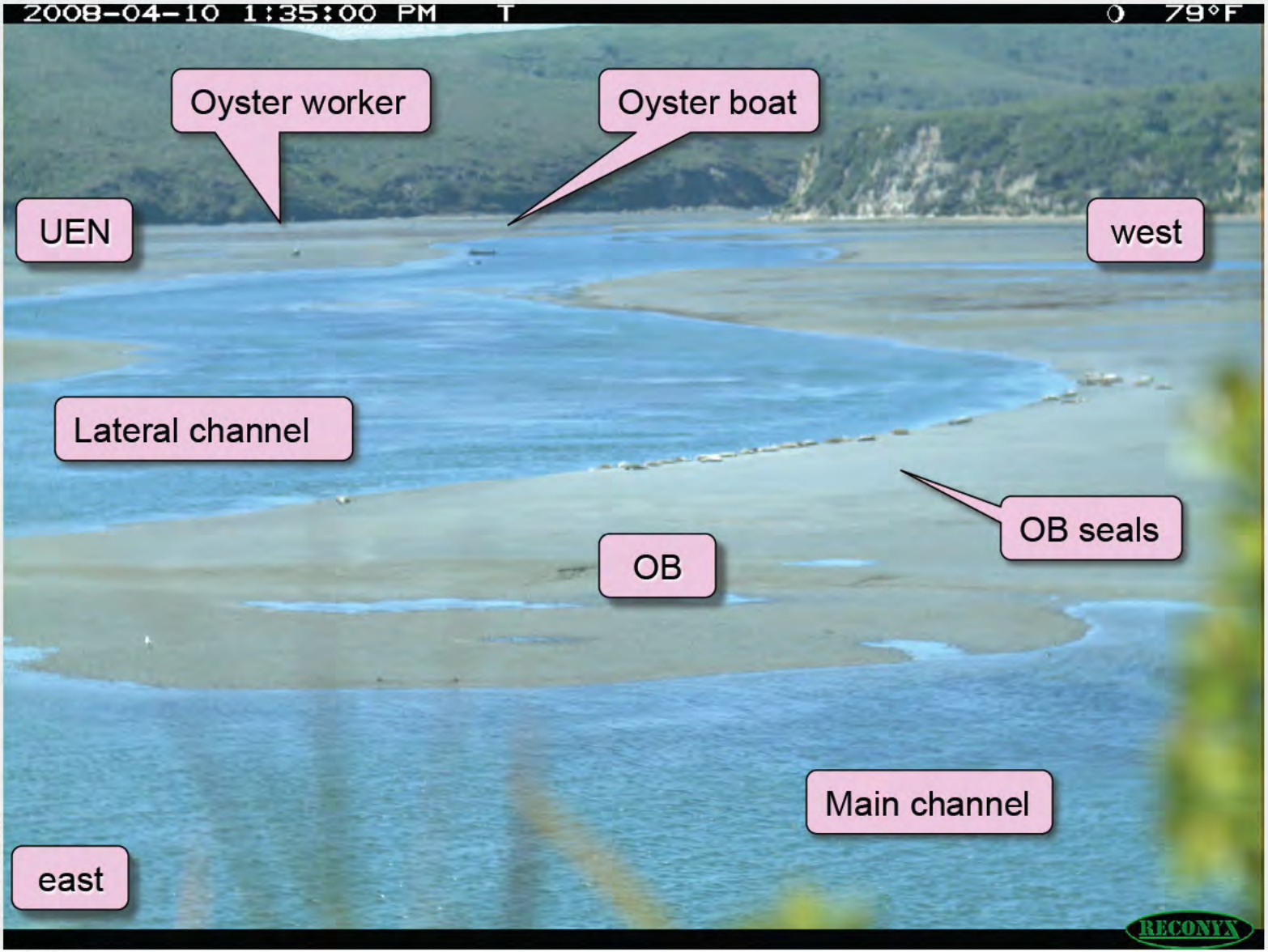
There were 12 areas where oyster bags are scattered in intertidal areas covering a total of approximately 10 acres (some site areas estimated from a distance). Since eelgrass does


Aerial photos provided by NPS do not support these small areas away from beds 17, 20, 14, & 15 and claimed to be near seal haul-out areas. No photos have been provided by NPS that clearly show oyster bags in any areas other than the standard beds 17 and 20 on UEN and OB.
National Park Service
Point Reyes National Seashore
Marin County, CA
N
W
E
S
0
500
1,000
1,500
Feet
Oyster Rack
Aquaculture lease
Seal Protection Zone
Aquaculture Material (2008) - 13 acres
Possible Aquaculture Material (2008) - 1 acre
* Background imagery acquired on March 4th 2008

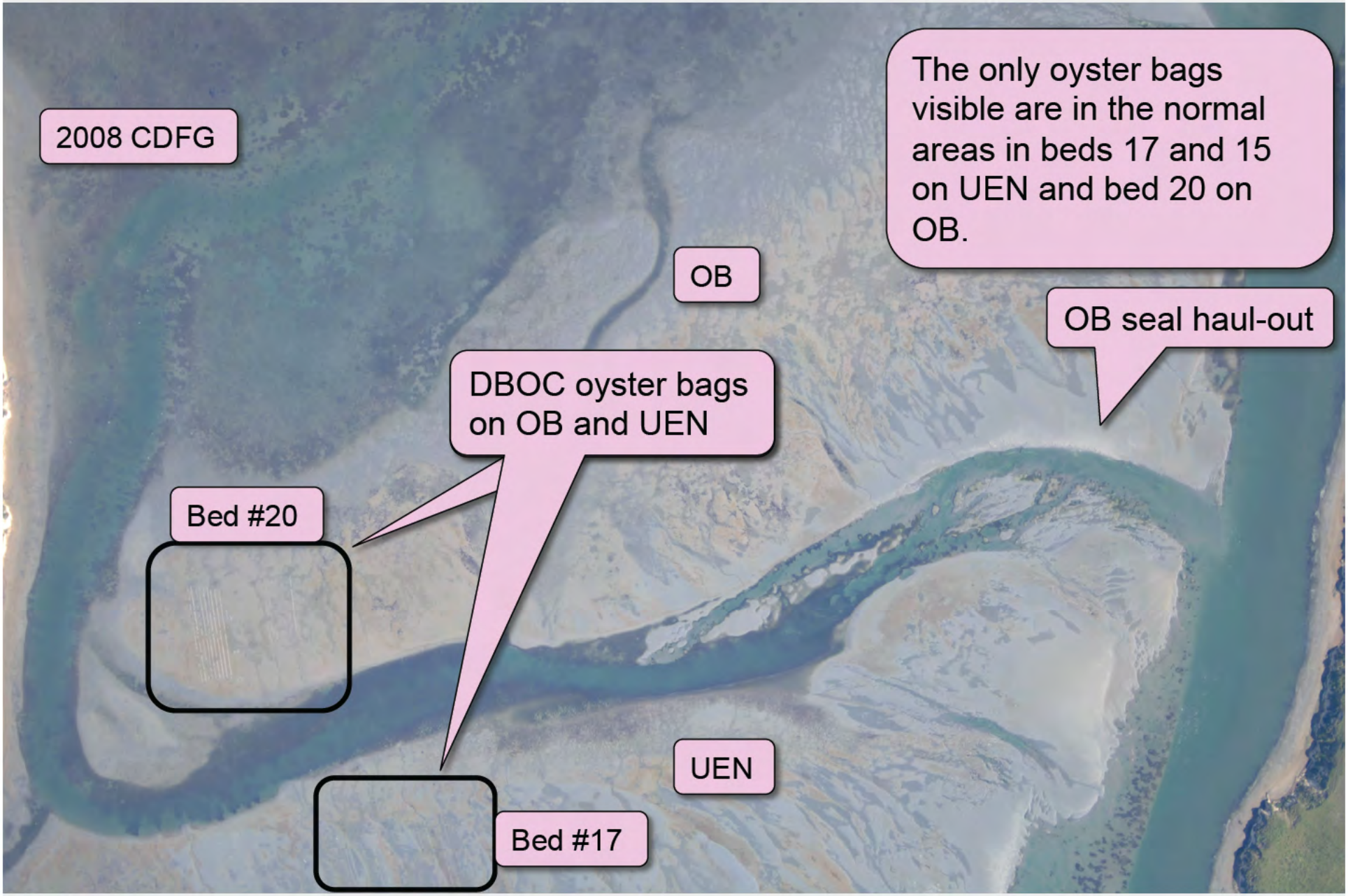

Becker provided two different NPS 2008 maps of oyster bags. In this one, the areas near the haul-out sites are reduced compared to the previous slide.
Why did the 2008 maps change and the small areas of oyster bags increase?
National Park Service
Point Reyes National Seashore
Marin County, CA
N
W
E
S
0
200
400
600
800
Feet
Oyster Rack
Current Oyster Bag Area
Aquaculture lease
Seal Protection Zone
From Figure 1
From Figure 2
* Background imagery acquired on March 4th 2008

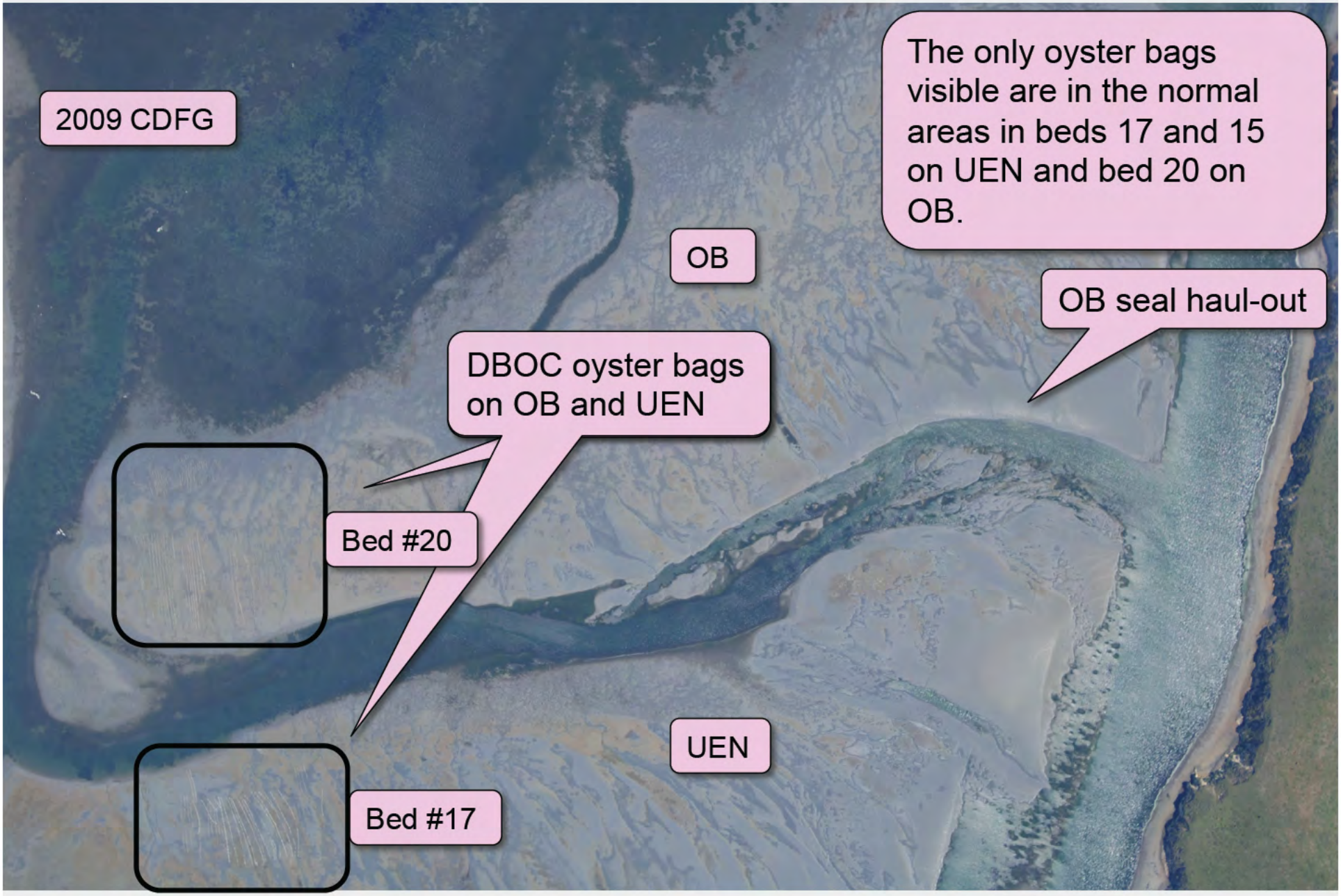

Aerial photos provided by NPS do not support these areas away from beds 17, 20, 14, & 15 and claimed to be near seal haul-out areas in '07 & '08. To date, after repeated requests, no photos have been provided by NPS that support these areas.
OB
UEN
Legend
Aquaculture Material 2005
Aquaculture Material 2007
Aquaculture Material 2008
Aquaculture Material 11/2009
Seal Protection Zone
Aquaculture lease
N
0
125
250
500
750
1,000
Meters

281,000 photos from NPS secret cameras ('07-'10) show oyster boats & workers at west end tending beds #17 (UEN) & #20 (OB), nowhere near eastern oyster bag areas drawn on NPS 2007 & 2008 maps



29


2008 CDFG
The only oyster bags visible are in the normal areas in beds 17 and 15 on UEN and bed 20 on OB.
OB
OB seal haul-out
DBOC oyster bags on OB and UEN
Bed #20
UEN
Bed #17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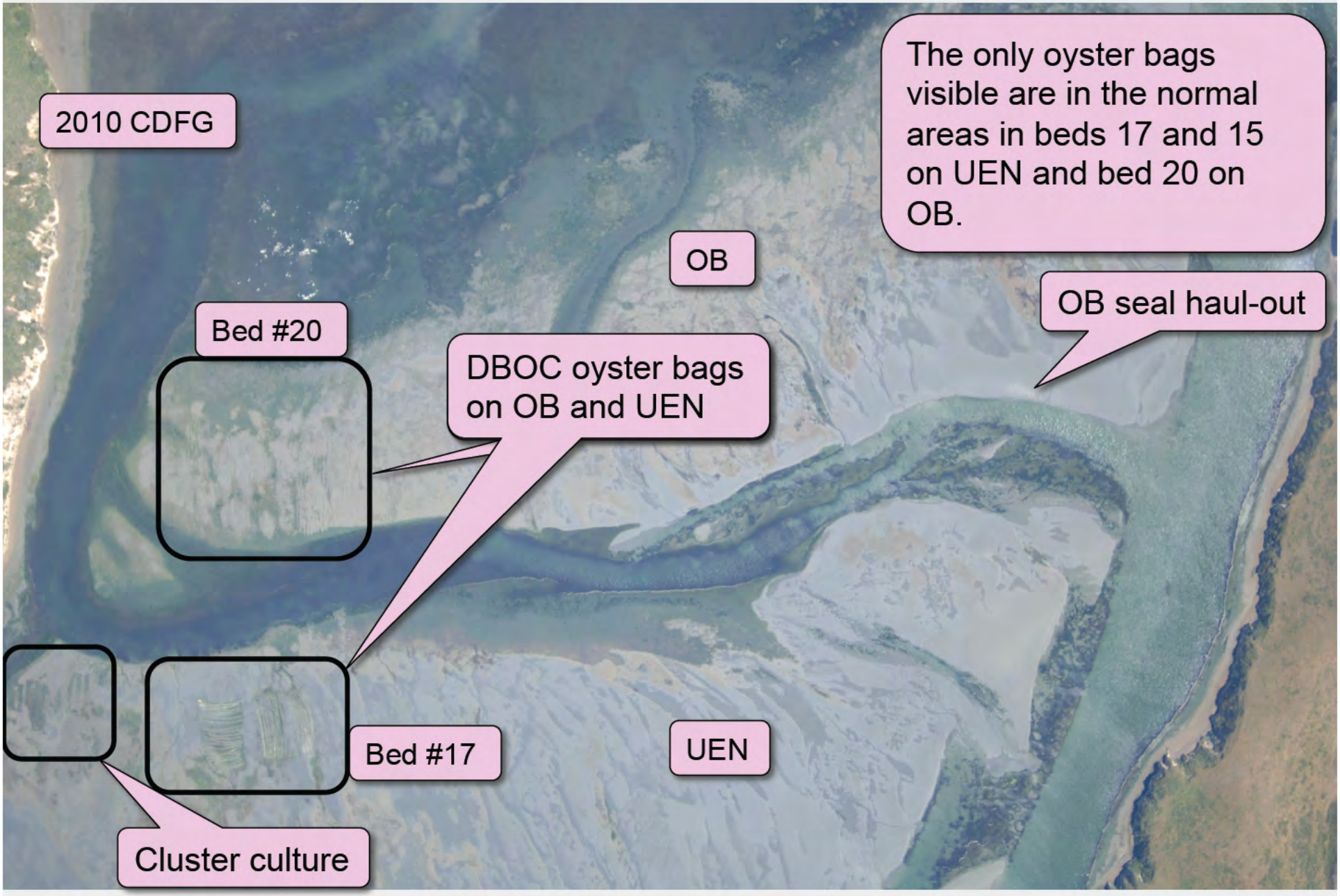
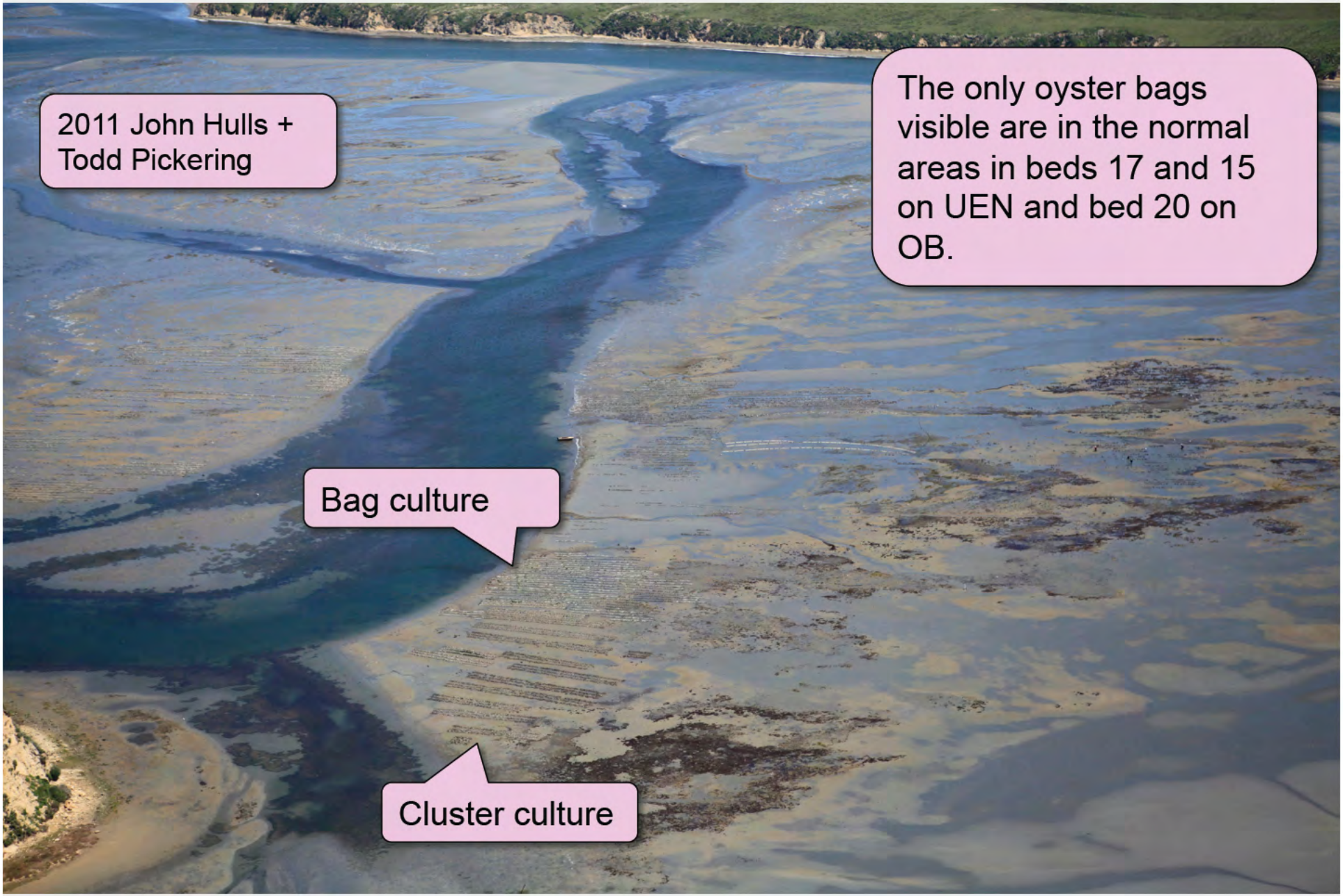
OB
OB seal haul-out
DBOC oyster bags on OB and UEN
Bed #20
UEN
Bed #17


2010 CDFG
The only oyster bags visible are in the normal areas in beds 17 and 15 on UEN and bed 20 on OB.
OB
OB seal haul-out
Bed #20
DBOC oyster bags on OB and UEN
Bed #17
UEN
Cluster culture


2011 John Hulls + Todd Pickering
The only oyster bags visible are in the normal areas in beds 17 and 15 on UEN and bed 20 on OB.
Bag culture
Cluster culture

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   NPS did not provide conclusive data to support major model in paper

We asked for all data (i.e. photographs & notebooks) supporting the numbers in this Figure.

What is basis for Becker 2011 claim that JOC had no oyster activity at UEN/OB in 2000-2004?

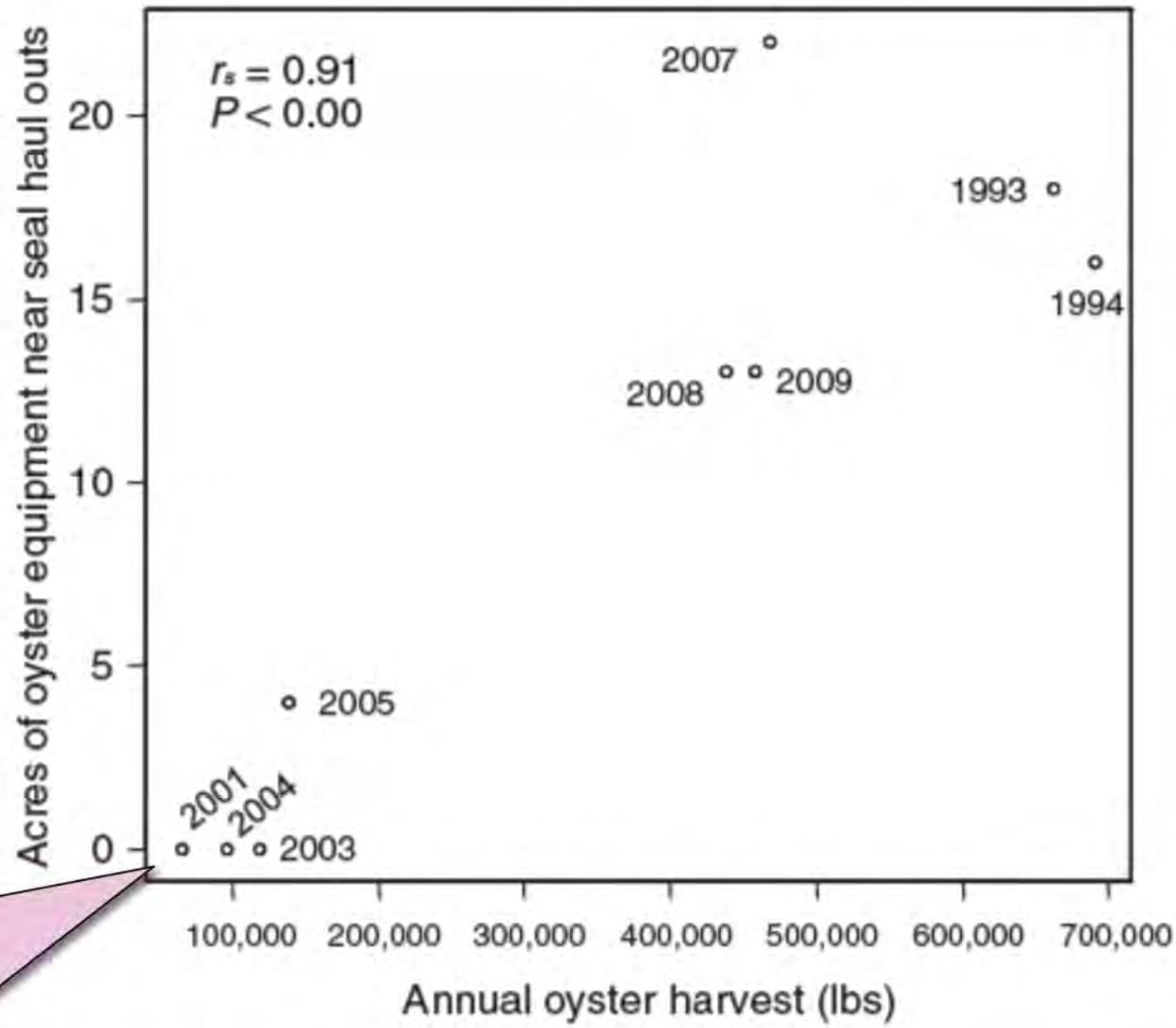

Figure 4. Relationship between annual oyster harvest and the acreage of oyster equipment near (<300 m) or adjacent to seal haul-out sites.

Becker 2011 made incorrect inferences in Table A1

Table A1.

Year	Oyster harvest (lbs)	Inferred level of mariculture use of sandbars near seals	Source(s) of inference	Analysis scale			
				Haul-out site	Intra-colony	Regional	Seal data source
1982	360,004	high	harvest data		x	x	SGA/A&H
1983	440,139	high	harvest data		x	x	SGA/A&H
1986	437,043	high	harvest data		x		SGA
1987	634,869	high	harvest data, oblique image of bags		x		SGA
1989	549,953	high	harvest data		x		SGA
1991	442,745	high	harvest data		x		SGA
1992	606,484	high	harvest data		x		SGA
1993	662,388	high	aerial image of bags		x		SGA
1997	476,791	high	harvest data	x	x	x	NPS
1998	292,188	high	harvest data, higher than 2005	x	x	x	NPS
1999	125,749	modelled high & low	slightly higher than 2000-2004, declining	x	x	x	NPS
2000	34,094	low	lower than 2002-2004	x	x	x	NPS
2001	65,676	low	aerial image of absence of bags	x	x	x	NPS
2002	78,064	low	DTP, pers. obs, harvest data	x	x	x	NPS
2003	118,643	low	aerial image of absence of bags	x	x	x	NPS
2004	96,754	low	DTP, pers. obs, harvest data	x	x	x	NPS
2005	138,958	high	aerial image of bags, increasing harvest	x	x	x	NPS
2006	291,538	high	increasing harvest, bags in '05	x	x	x	NPS
2007	468,000	high	aerial image of bags	x	x	x	NPS
2008	438,000	high	aerial image of bags	x	x	x	NPS
2009	458,000	high	aerial image of bags	x	x	x	NPS

Becker 2009 had been criticized by the NAS for using annual oyster harvest as a surrogate for oyster activity at UEN/OB during pupping season (March-May). Becker 2011 used a series of "inferences" to claim that they could infer oyster activity at UEN/OB during pupping season. This was used to drive OYST Hi/Low model. However, the inferences were incorrect.

Becker 2011 made incorrect inferences in Table A1

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2003	118,643	low	aerial image of absence of bags
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2005	138,958	high	aerial image of bags, increasing harvest
2006	291,538	high	increasing harvest, bags in '05
2007	468,000	high	aerial image of bags
2008	438,000	high	aerial image of bags
2009	458,000	high	aerial image of bags

OYST Hi/Low is based upon this "inferred" level of activity at UEN/OB during pupping season

Becker's "inferences" for UEN/OB pupping season activity came from aerial photos, harvest data, and David Press observations

Table A1.

Year	Oyster harvest (lbs)	Inferred level of mariculture use of sandbars near seals	Source(s) of inference
1997	476,791	high	harvest data
1998	292,188	high	harvest data, higher than 2005
1999	125,749	modelled high & low	slightly higher than 2000-2004, declining
2000	34,094	low	lower than 2002-2004
2001	65,676	low	aerial image of absence of bags
2002	78,064	low	DTP, pers. obs, harvest data
2003	118,643	low	aerial image of absence of bags
2004	96,754	low	DTP, pers. obs, harvest data
2005	138,958	high	aerial image of bags, increasing harvest
2006	291,538	high	increasing harvest, bags in '05
2007	468,000	high	aerial image of bags
2008	438,000	high	aerial image of bags
2009	458,000	high	aerial image of bags

INFERENCES:

(1) Annual oyster harvest: irrelevant to UEN/OB during pupping season (Mar-May)

(2) Aerial photos: NPS misinterpreted the photos, seeing oyster bags where they were not and not seeing oyster bags where they were

(3) Personal observations: memories were incorrect or observer had not visited area

(4) Becker failed to obtain key data from CDPH, CDFG, JOC, and DBOC

Three types of oyster culture at UEN/OB: aerial photos show stick culture & cluster culture, but usually not bag culture

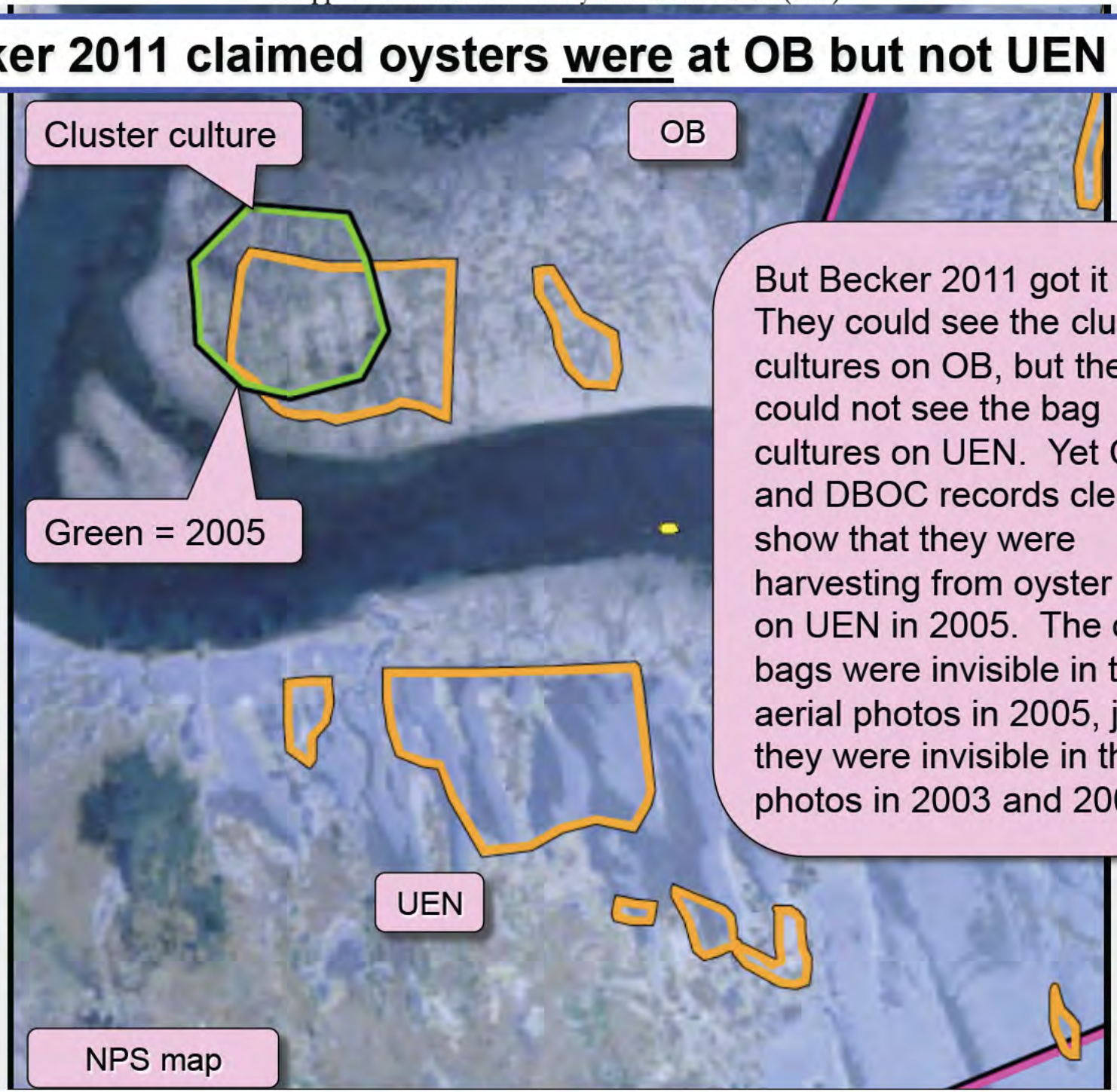
Three types of oyster culture systems used over the years at OB & UEN:

(1) **Stick culture**: sticks protruding from sand by several feet with hanging clusters; very visible in 1993 & 1994 photos; used by JOC; phased out in mid to late '90's

(2) **Cluster culture**: cluster of oysters not in bags but lying on sandbar; just visible in 2003-2005 photos on OB; largely replaced by bags and used sparingly today

(3) **Bag culture**: oysters in bags on sandbar; least visible in aerial photos (only with high resolution and right light angle); prevalent but not seen in earlier photos

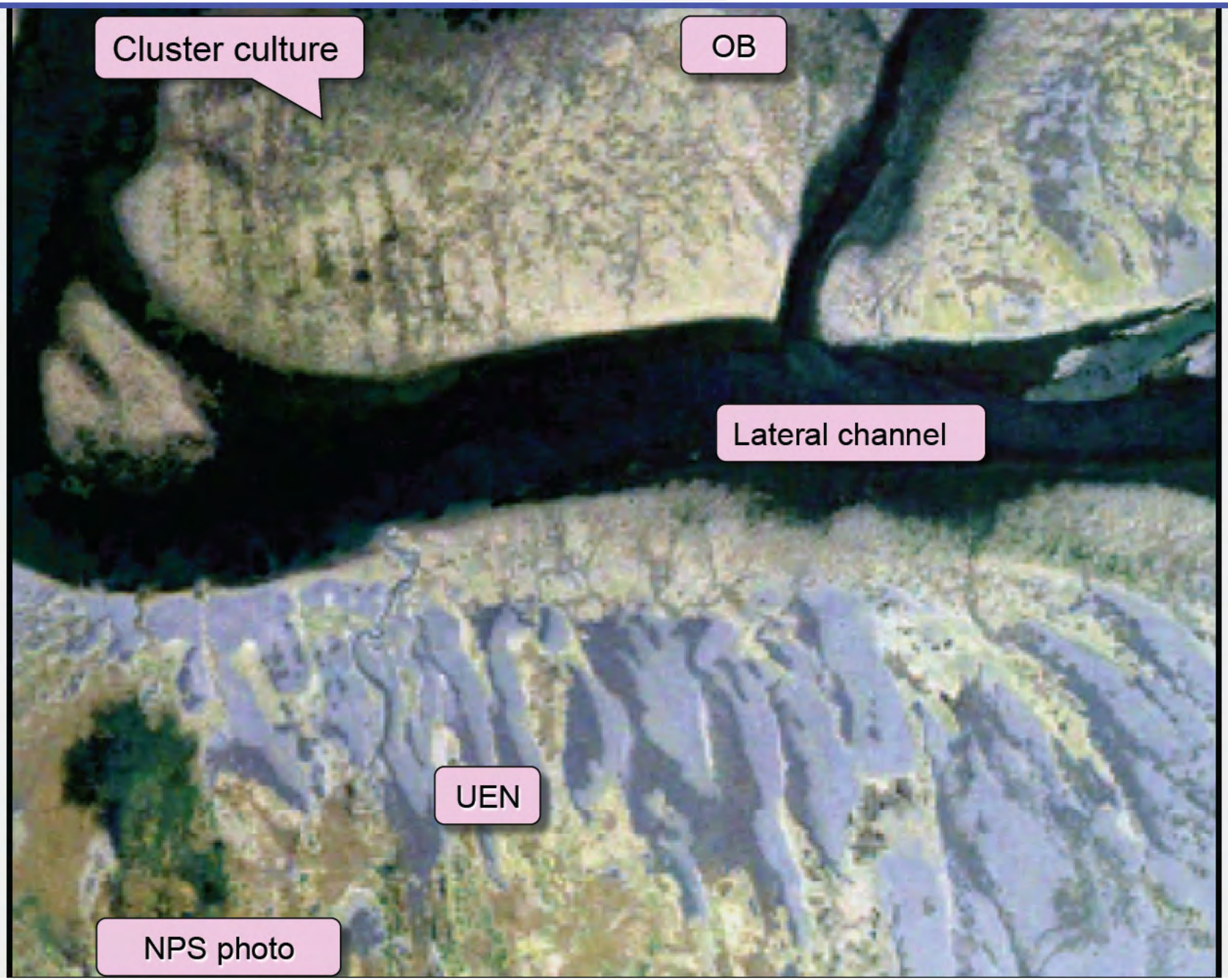
Becker 2011 claimed oysters were at OB but not UEN in '05



But Becker 2011 got it wrong. They could see the cluster cultures on OB, but they could not see the bag cultures on UEN. Yet CDPH and DBOC records clearly show that they were harvesting from oyster bags on UEN in 2005. The oyster bags were invisible in the aerial photos in 2005, just as they were invisible in the photos in 2003 and 2004.

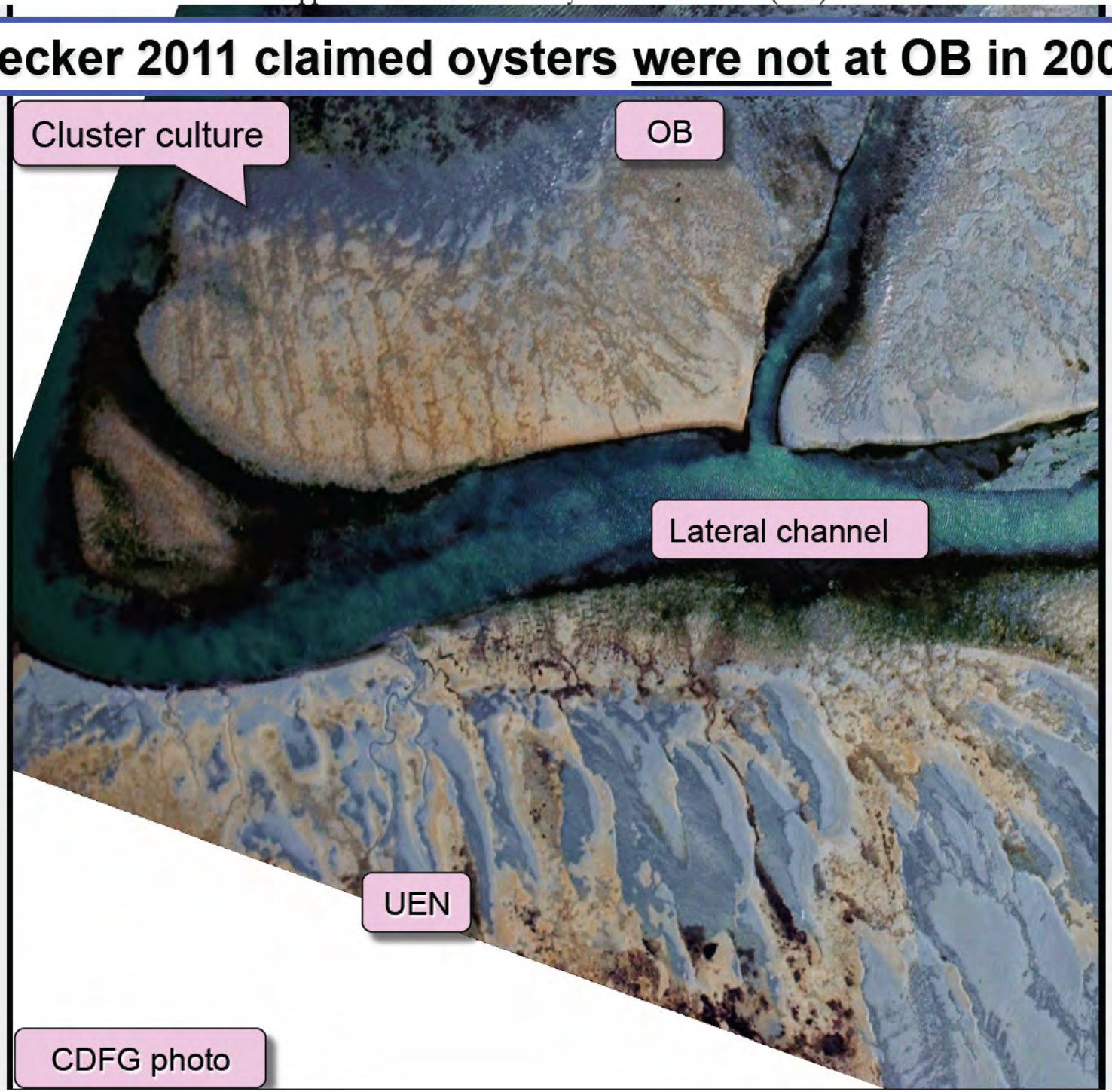
40

Becker 2011 claimed oysters <u>were</u> at OB but not UEN in '05

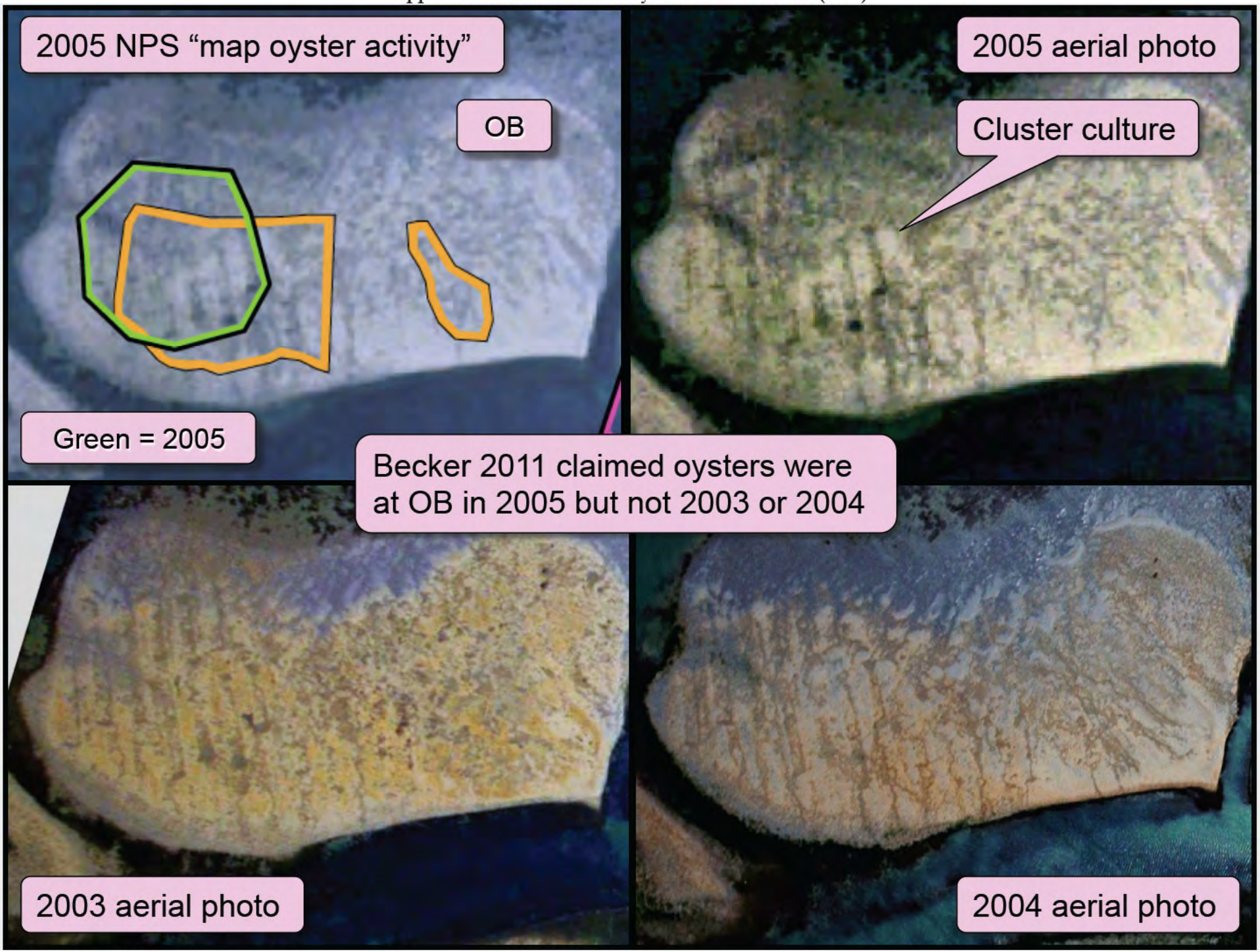


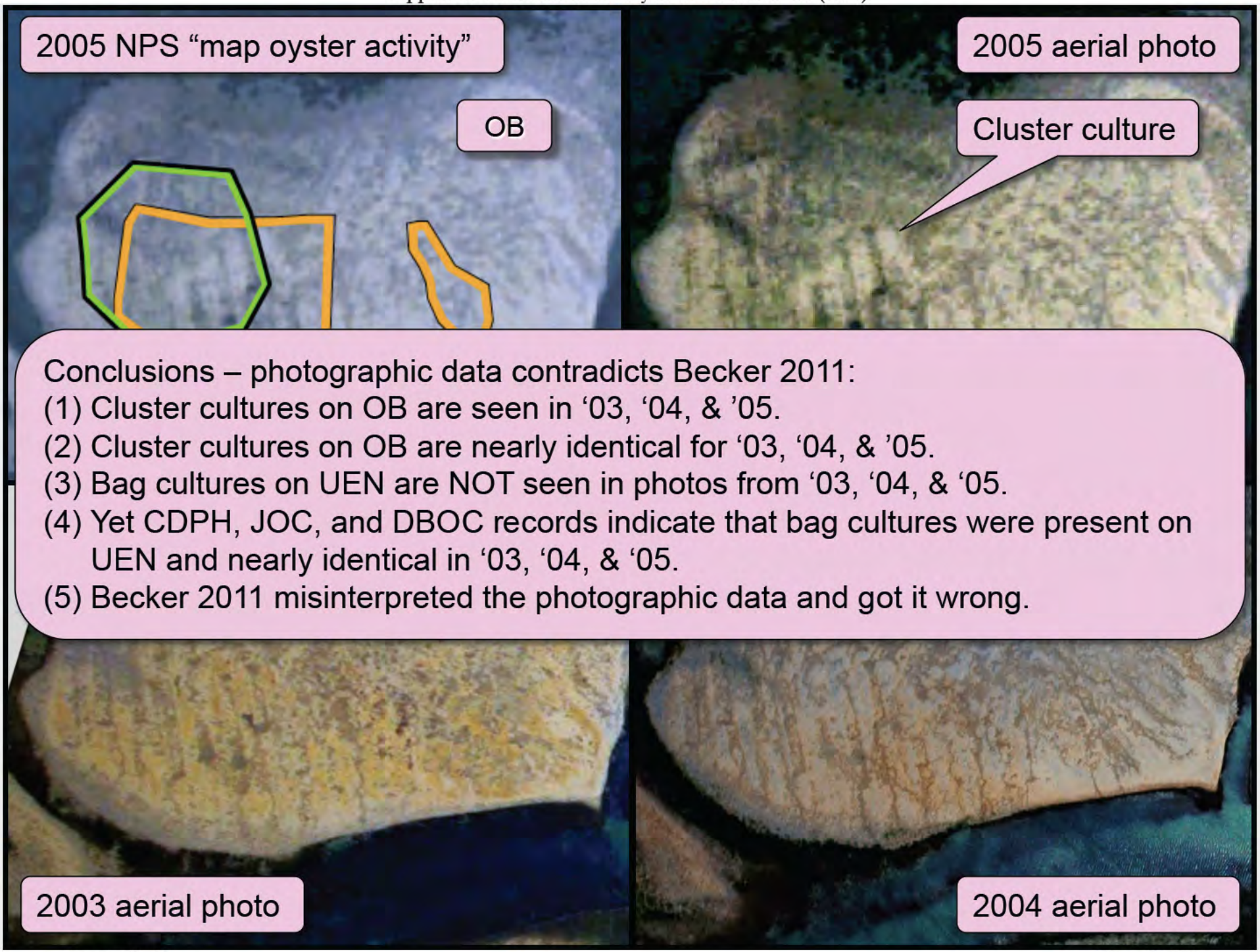
41

Becker 2011 claimed oysters <u>were not</u> at OB in 2004

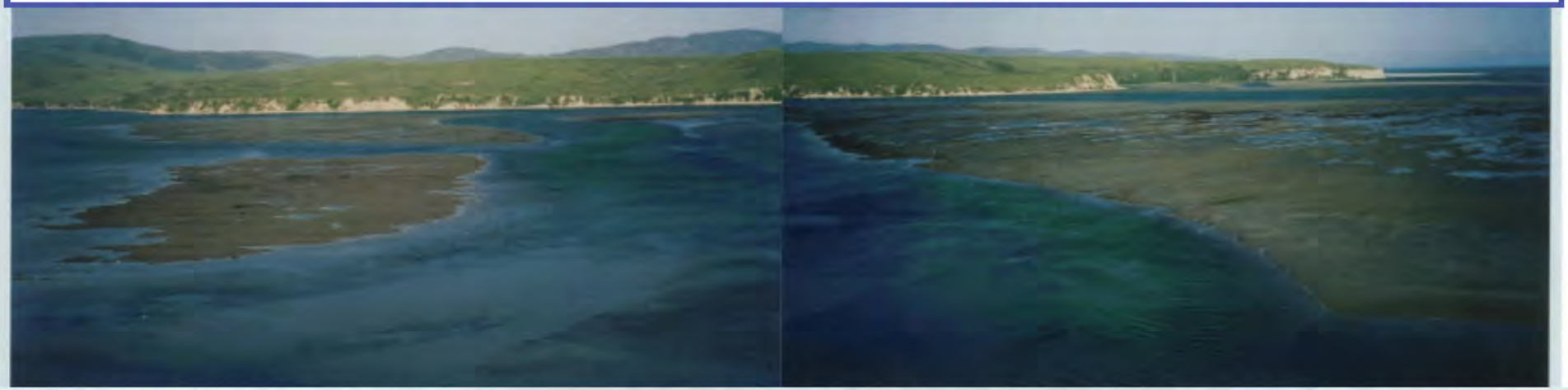


42


2005 NPS "map oyster activity"
OB
Green = 2005
2005 aerial photo
Cluster culture
Becker 2011 claimed oysters were at OB in 2005 but not 2003 or 2004
2003 aerial photo
2004 aerial photo


2005 NPS "map oyster activity"
OB
2005 aerial photo
Cluster culture
Conclusions – photographic data contradicts Becker 2011:
(1) Cluster cultures on OB are seen in '03, '04, & '05.
(2) Cluster cultures on OB are nearly identical for '03, '04, & '05.
(3) Bag cultures on UEN are NOT seen in photos from '03, '04, & '05.
(4) Yet CDPH, JOC, and DBOC records indicate that bag cultures were present on UEN and nearly identical in '03, '04, & '05.
(5) Becker 2011 misinterpreted the photographic data and got it wrong.
2003 aerial photo
2004 aerial photo

Becker 2011 Relied on David Press "pers. obs." and 2003 photos while UC Davis student working at Barries Bay …



Photos of lower Drakes Estero taken from western shore. Photos begin to the east, facing down lateral channel, and then sweep south to the mouth of Barries Bay. Photos taken by David Press in spring of 2003 sometime between April 18 and May 19. Exact date is not known.

… but Kevin Lunny has photos from same location on January 1, 2009 and no bags are visible in them as well.

Conclusion: from this vantage point and at this height, the oyster bags are not visible. NPS and CDFG aerial photos show large numbers of oyster bags in 2009 when Kevin Lunny took his photo, but they are not seen in these photos. Thus the David Press photographic data are inconclusive, and are contradicted, as shown here, by CDPH records, JOC employee statements, and aerial photographs.

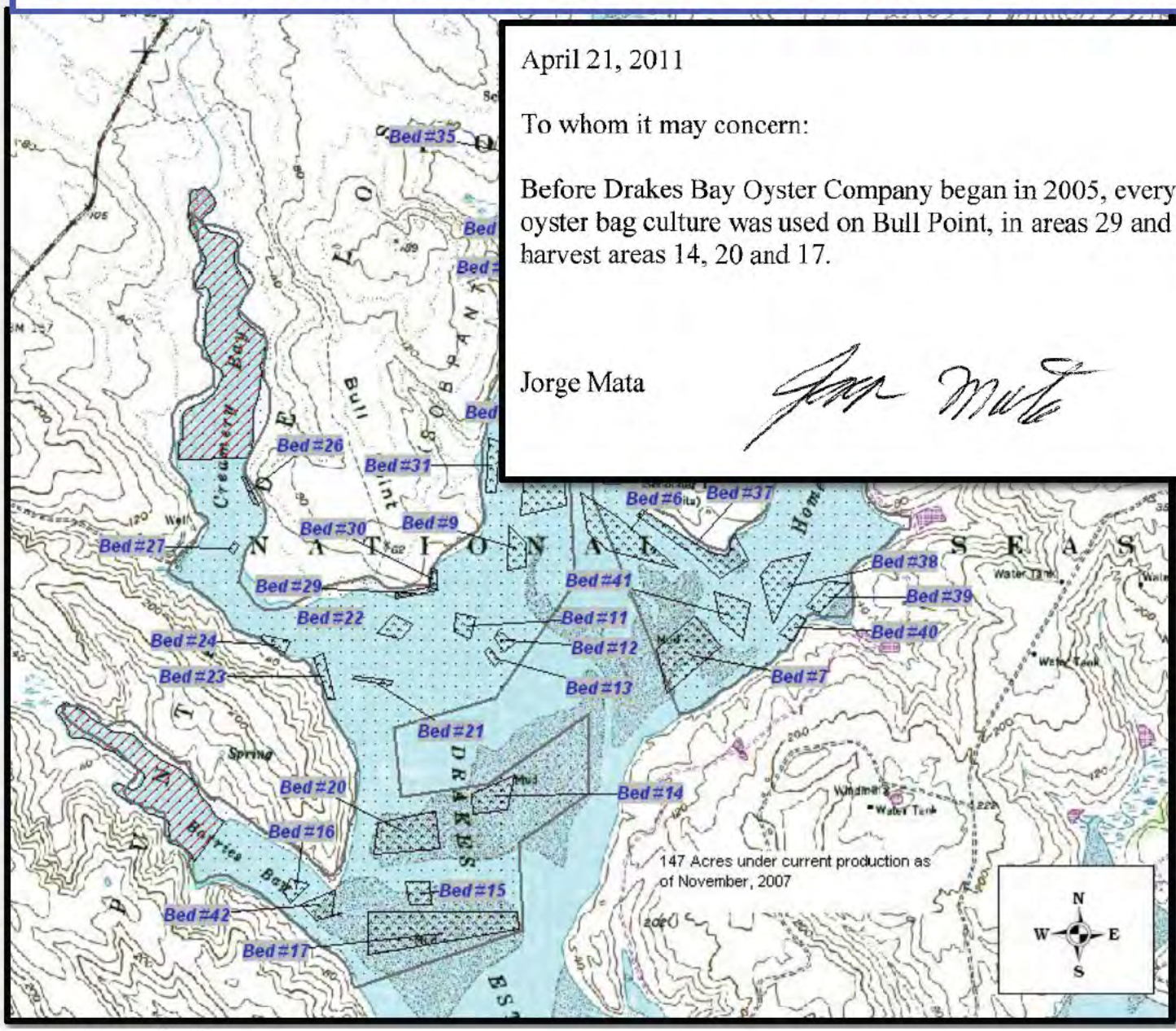
Former Johnson's Oyster Company owner, manager, and foreman claim JOC harvested from OB & UEN until the end

April 21, 2011

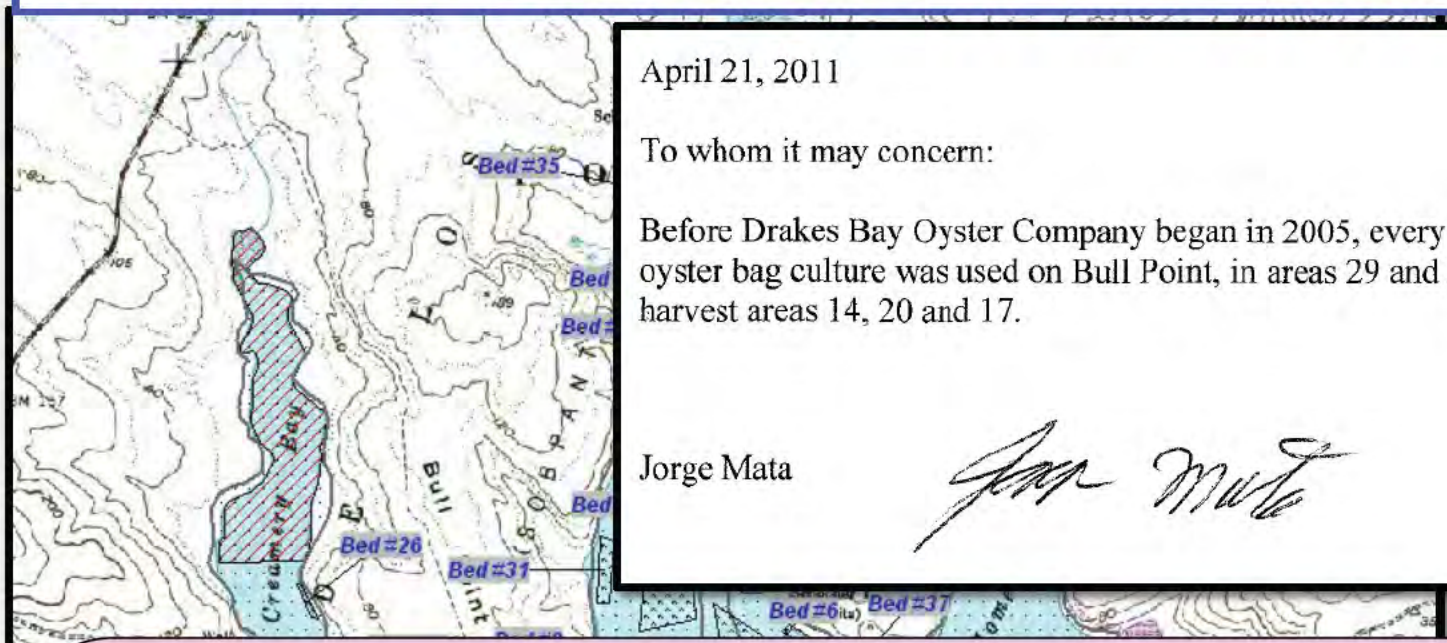
To whom it may concern:

Before Drakes Bay Oyster Company began in 2005, every year since 1984 to the present, oyster bag culture was used on Bull Point, in areas 29 and 30 and on Berries Bar in harvest areas 14, 20 and 17.

Jorge Mata



Former Johnson's Oyster Company owner, manager, and foreman claim JOC harvested from OB & UEN from '00 to '04



April 21, 2011

To whom it may concern:

Before Drakes Bay Oyster Company began in 2005, every year since 1984 to the present, oyster bag culture was used on Bull Point, in areas 29 and 30 and on Berries Bar in harvest areas 14, 20 and 17.

Jorge Mata

We received statements three key people, all claiming that JOC continued to harvest oysters from bed #17 (UEN), bed #20 (OB), and other neighboring beds throughout 2000-2004, even as overall production decreased. The reason was simple: bed #17 is the only place where JOC or DBOC can harvest after rainfall, and thus is key for maintaining harvest in months such as March and into April (it is the only place in California where CDPH permits harvesting after rainfall).

(1) Jorge Mata, former JOC foreman and current DBOC foreman;
(2) Nellie Gamez, former JOC office manager who collected all records;
(3) Mark Johnson, former JOC co-owner

California Dept. of Public Health records of oyster harvest during rainy season show harvest from bed #17 in '01 to '04

Suggested Forms
Shellfish Ledger Records - 1

Shellfish Harvest Record

Company Name: Johnson Oyster Co.
Certificate No.: #6

Harvest Area	Harvest Date	Species	Quantity
22	11-24-01	1:00 - 1:30	40
4	11-29-01	12:30 - 1:00	140
19	11-29-01	1:00 - 3:00	130
17	12-6-01	10:00 - 11:00	160
17	12-7-01	11:00 12:00	140
8	12-11-01	3:00 - 4:00	170
8	12-13-01	3:00 - 4:00	240
17	12-14-01	2:30 - 3:00	60
30	12-15-01	1:00 - 1:15	25 Bags
17	12-18-01	9:00 - 10:00	180
17	12-19-01	9:00 - 10:30	250
open 38	12-20-01	9:00 - 10:00	270
open 22	12-20-01	10:30 - 11:30	220
9	12-22-01	11:00 - 12:30	700
7	12-26-01	12:15 - 12:45	180

1020
980

Page ____

17 - 12-6-01

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California Dept. of Public Health records of oyster harvest during rainy season show harvest from bed #17 in '01 to '04

FROM : PHONE NO. :

SHELLFISH HARVESTER'S MONTHLY REPORT OF RAINFALL AND HARVEST OPERATIONS
SIDE 1 OF 2

Harvester: Johnson Oyster CO. Growing Area: Drakes Estero
Month/Year: JANUARY 2003 Rain Gauge Location:

this form is for the use of california certified shellfish growers who harvest from conditionally approved areas. Growers are required to complete and form in accordance with the management plan for the conditionally approv area in which they conduct harvesting operations.

Day	Rainfall (in.)	Closure/Re-opening Times	Harvest Times	Remark RAIN IS
1-	.30	closed inner		8:00 A
2-	0.0	Called Rincheck	#17 2:30 3:30	8:00 A
3-	0.0	outer bay open 8:00 am	#38 3:00 4:15	8:00 A
4-	0.0			8:00
5-	0.0			8:00
6-	0.0			8:00
7-	0.0	Inner open 9:00	#38 8:45 10:00	8:00
8-	0.0		#9 9:30 11:00	8:00
9-	0.70	called		8:00
10-	0.90	closed	#38 11:00 12:30	8:00
11-	0.0	closed		8:00
12-	Help?	closed		8:00
13-	.70	closed 3:00		8:00
14-	.30		#7 2:00 3:30	8:00
15-	.10			8:00

(CONTINUED ON SIDE 2)

STATE OF CALIFORNIA
DEPARTMENT OF HEALTH SERVICES
FORM SSP 12 (5/91)

SHELLFISH HARVESTER'S MONTHLY REPORT OF RAINFALL AND HARVEST OPERATIONS
SIDE 1 OF 2

Harvester: Johnson Oyster CO. Growing Area: Drakes Estero
Month/Year: APRIL 2003 Rain Gauge Location: UP-STAIRS ROOF

this form is for the use of california certified shellfish growers who harvest from conditionally approved areas. Growers are required to complete and file this form in accordance with the management plan for the conditionally approved area in which they conduct harvesting operations.

Day	Rainfall (in.)	Closure/Re-opening Times	Harvest Times	Remark Rain is checked From 8:00AM To 8:00AM
1-	0.0		#8 9:00 9:45	8:00AM
2-	0.20		#4 9:00 10:00	8:00 AM
3-	0.10		#4 11:00 12:30	8:00 AM
4-	0.0		#8 9:00-10:45 2:00-3:30	8:00 AM
5-	0.0		#4 1:00 2:30	8:00 AM
6-	0.0			8:00 AM
7-	0.0		38 8:30 9:45	8:00 AM
8-	0.0		#9 9:00 10:30	8:00 AM
9-	0.0		#9 9:30 11:00	8:00 AM
10-	0.0		#38 8:45 11:00	8:00 AM
11-	0.0		#8 10:00 10:45	8:00 AM
12-	0.45 Help 0.40	closed 12:00		8:00 AM
13-	.80	Closed		8:00 AM Called Rain check
14-	0.80	closed	#17 2:00 3:30	8:00 AM
15-	0.0	closed	#17 11:00 12:45	8:00 AM

(CONTINUED ON SIDE 2)

STATE OF CALIFORNIA
DEPARTMENT OF HEALTH SERVICES
FORM SSP 12 (5/91)

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The years 2003, 2004, & 2005 were nearly identical: cluster cultures seen in photos and bag cultures not seen in photos

Becker 2011 claimed there were no oysters harvested at OB & UEN in last five JOC years (2000-2004), and DBOC increased activity in 2005. This was incorrect.

It is contradicted by CDPH records.
It is contradicted by JOC and DBOC employees, managers, and owners.
It is contradicted by the CDFG aerial photographs.

The 2003, 2004, & 2005 photos share two things in common.
(1) Just visible are similar oyster clusters (cluster culture) on OB (bed #20)
(2) Not visible are the equally similar oyster bags (bag culture) on UEN (bed #17)

Had Becker worked with Lunny, as MMC suggested, he would have learned this.

Analysis of Becker et al. 2011: conclusions part 2

Evidence for long-term spatial displacement of breeding and pupping harbour seals by shellfish aquaculture over three decades†

BENJAMIN H. BECKER*, DAVID T. PRESS and SARAH G. ALLEN
US National Park Service, Point Reyes National Seashore, Point Reyes Station, CA 94956, USA

1. Annual oyster harvest is not surrogate for UEN/OB pupping season

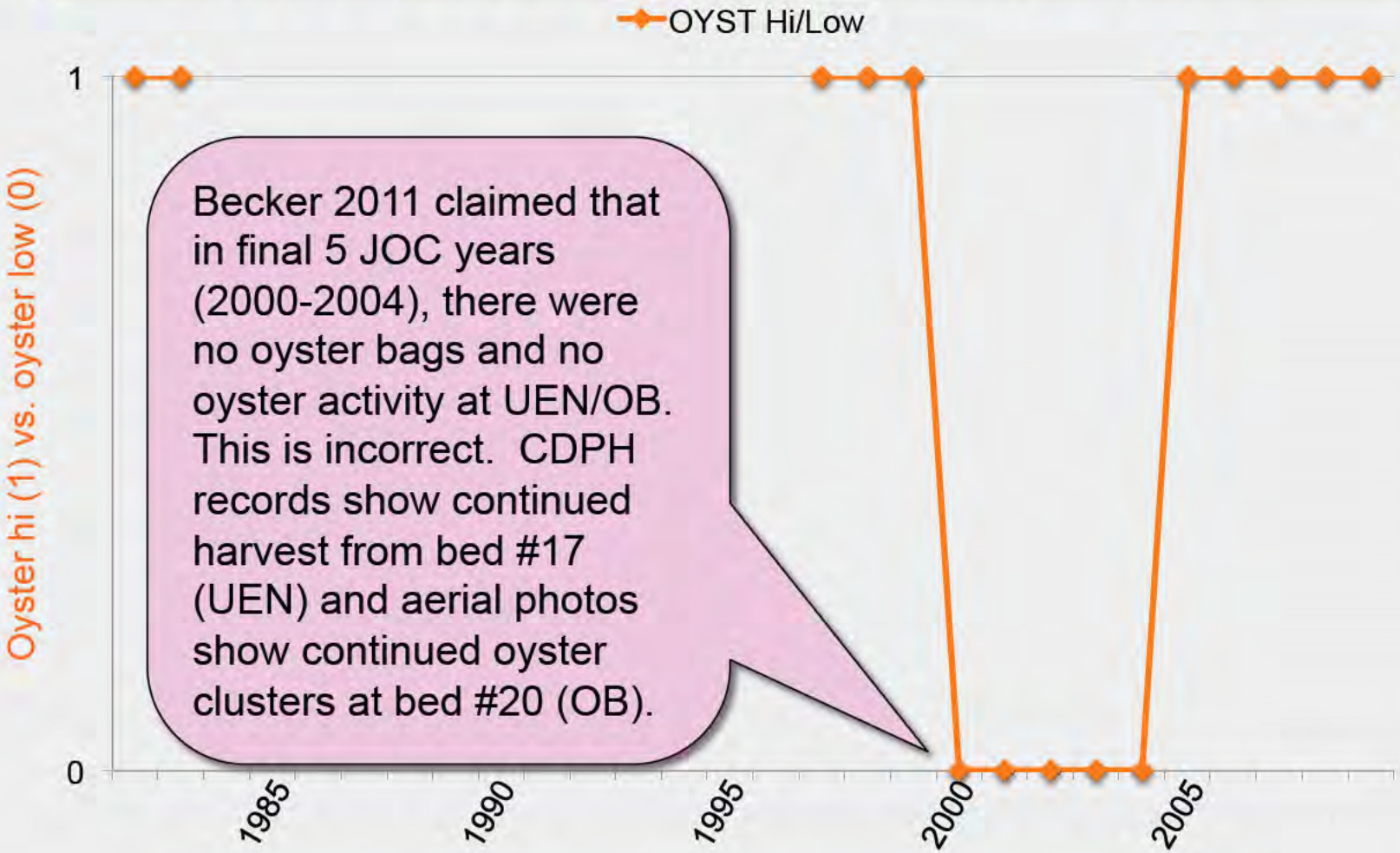
2. Seal haul-out map is misleading: seals and oysters do not overlap

3. Claims and maps of oyster bags in pupping areas are incorrect

4. Claims of zero oyster bags at OB/UEN from 2000-2004 are incorrect
   CDPH records show JOC continued to harvest from UEN & OB

5. **Inferences that drove OYST Hi/Low categorical model are incorrect**
   NPS did not provide conclusive data to support major model in paper

Is OYST Hi/Low a surrogate for oyster activity at OB/UEN during pupping season? A: No



OYST Hi/Low categorical oyster activity

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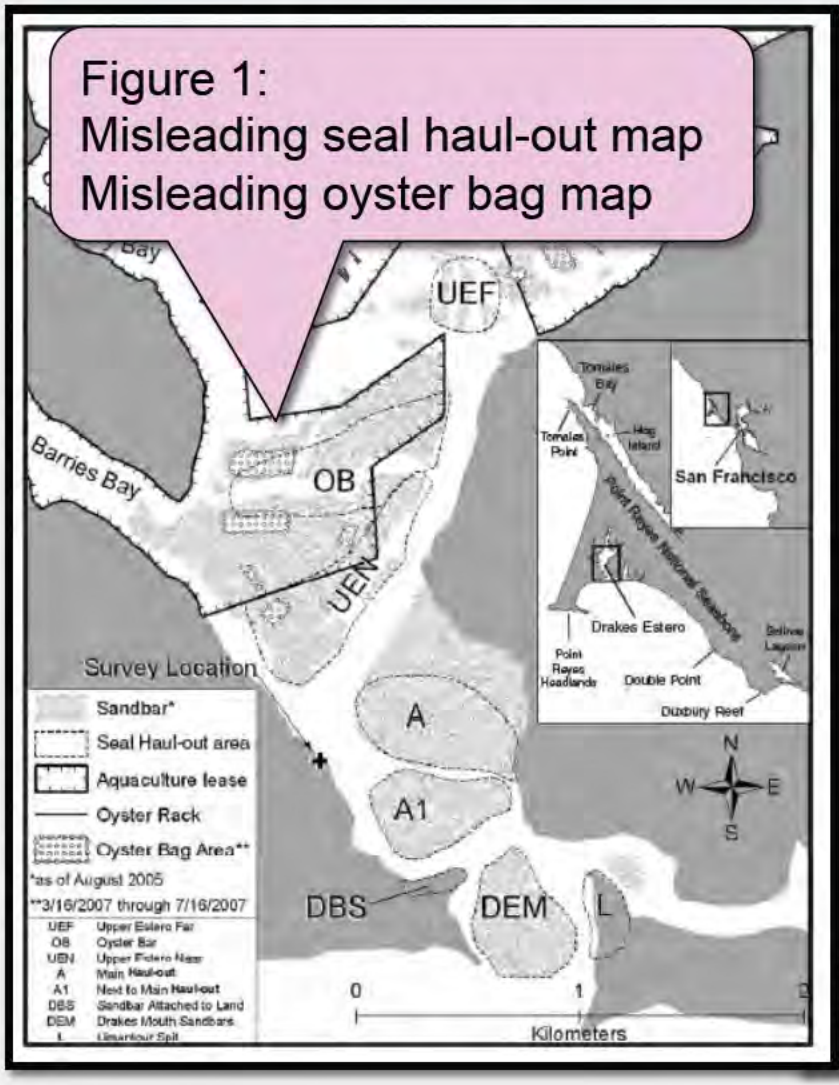
Becker 2011 used incorrect data and made inaccurate and misleading claims in Figures 1 & 4

Becker 2011 used incorrect inferences and misinterpreted photographs in Table 1A

Becker 2011, based upon false inferences, used OYST Hi/Low as inappropriate surrogate for UEN/OB

Conclusion: Becker 2011 used incorrect data and made inaccurate and misleading claims in Figures 1 & 4



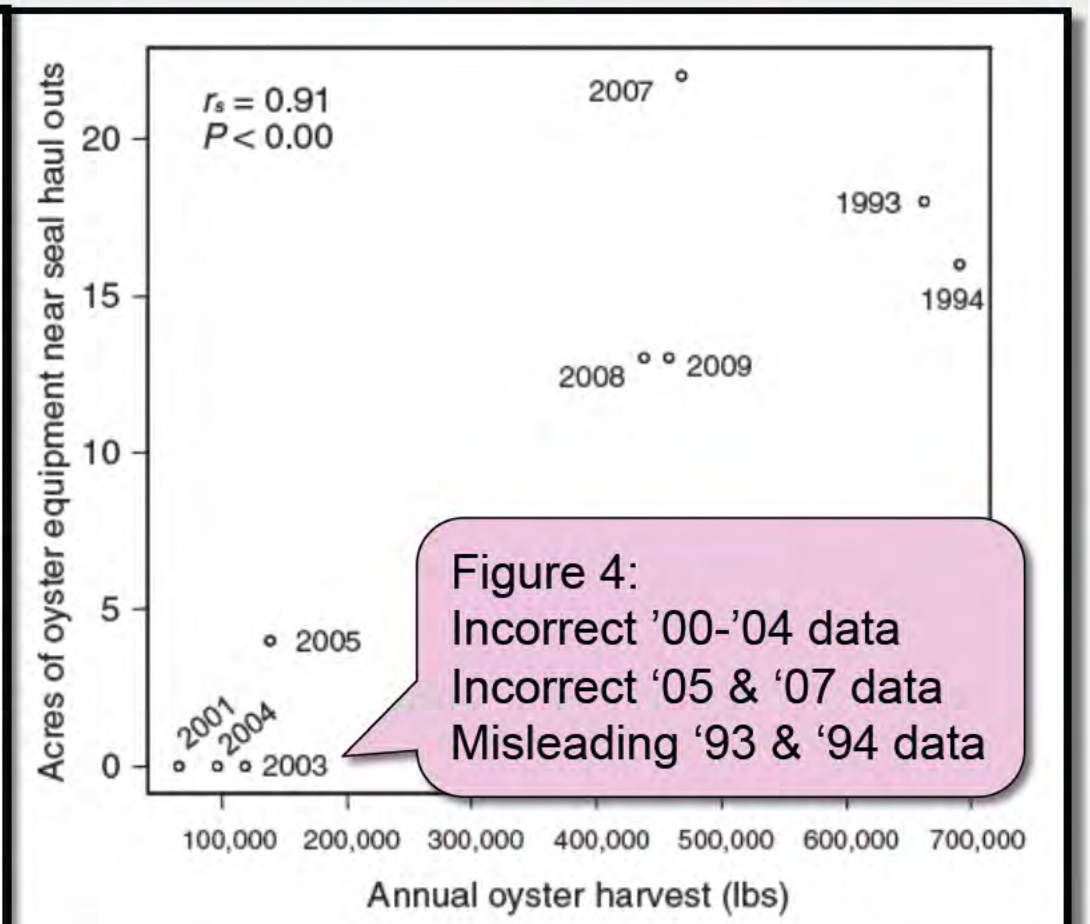


Figure 4. Relationship between annual oyster harvest and the acreage of oyster equipment near (<300 m) or adjacent to seal haul-out sites.

Conclusion: Becker 2011 used incorrect inferences and misinterpreted photographs in Figure 1A

Table A1.

Year	Oyster harvest (lbs)	Inferred level of mariculture use of sandbars near seals	Source(s) of inference	Analysis scale			
				Haul-out site	Intra-colony	Regional	Seal data source
1982	360,004	high	harvest data		x	x	SGA/A&H
1983	440,139	high	harvest data		x	x	SGA/A&H
1986	437,043	high	harvest data		x		SGA
1987	634,869	high	harvest data, oblique image of bags		x		SGA
1989	549,953	high	harvest data		x		SGA
1991	442,745	high	harvest data		x		SGA
1992	606,484	high	harvest data		x		SGA
1993	662,388	high	aerial image of bags		x		SGA
1997	476,791	high	harvest data	x	x	x	NPS
1998	292,188	high	harvest data, higher than 2005	x	x	x	NPS
1999	125,749	modelled high & low	slightly higher than 2000-2004, declining	x	x	x	NPS
2000	34,094	low	lower than 2002-2004	x	x	x	NPS
2001	65,676	low	aerial image of absence of bags	x	x	x	NPS
2002	78,064	low	DTP, pers. obs, harvest data	x	x	x	NPS
2003	118,643	low	aerial image of absence of bags	x	x	x	NPS
2004	96,754	low	DTP, pers. obs, harvest data	x	x	x	NPS
2005	138,958	high	aerial image of bags, increasing harvest	x	x	x	NPS
2006	291,538	high	increasing harvest, bags in '05	x	x	x	NPS
2007	468,000	high	aerial image of bags	x	x	x	NPS
2008	438,000	high	aerial image of bags	x	x	x	NPS
2009	458,000	high	aerial image of bags		x	x	NPS

Table 1A:
Incorrect inferences
Misrepresented photos
Misuse of harvest data

Analysis of Becker et al. 2011: conclusions part 2

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CDPH records show JOC continued to harvest from UEN & OB

5. Inferences that drove OYST Hi/Low categorical model are incorrect
NPS did not provide conclusive data to support major model in paper

Analysis of Becker et al. 2011: concluding comments

1. Title says "*long-term spatial displacement*" but analysis shows transient; authors failed to note their statistics driven by 2003 & 2004

2. Title says "*evidence*" oyster farm displaced seals but models fail; authors' data generates models 1000 times better than oyster activity

3. Title says "*three decades*" of data but 14 year gap; authors cherry picked 1982 & 1983 data – NPS previously denied these data existed

4. Analysis shows regional harbor seal population, events at Double Point, and elephant seals drive movements of harbor seals into Estero

5. Authors used incorrect seal haul-out maps, incorrect oyster bag maps, and misinterpreted aerial photos; never asked for Lunny data

6. Authors missed opportunity to determine if adaptive management succeeded with 92 (oyster boats) & 96 (kayak) management changes

7. Authors missed opportunity to use data to study biology of harbor seals and population dynamics; authors too focused on oyster farm