A retrospective assessment of marine ecological research using optimal α

by

Chuhan Zhao

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of

Bachelor of Science with Honours in Marine biology

Supervisor: Jeff Houlahan, Ph. D., Department. of Biological Sciences

THE UNIVERSITY OF NEW BRUNSWICK

SAINT JOHN

April 2020

ABSTRACT

Null hypothesis significance testing (NHST) is and has been for many decades broadly applied across disciplines, NHST's shortcomings have been identified and discussed since its introduction. Optimal alpha is a better method for setting statistical thresholds in NHST because it minimizes the overall probability of making errors. However, we don't know how often using optimal α would result in a different conclusion than NHST. I calculate optimal α for 433 tests from 2009-2018 published marine biology papers and compare conclusions with NHST. I find totally 24 % of conflicting results (small ES: 22 %; medium ES: 22 %; large ES: 29 %). For disagreement, optimal alpha has 97 % significant results at small ES, 54% at medium and 24% at large. Low observed p value tends to have disagreement. These results mean that failing to use optimal alpha may be inflating the probability of making wrong conclusions in marine biology.

DEDICATION

This work is dedicated to my parents, Hongping and Zhiyong, for their great care and encourage during the last 8 months. Any suggestions they could come up with are fresh ideas and sometimes are useful. Also, this work is dedicated to my supervisor Dr. Jeff Houlahan. With his explaining of optimal alpha, a new world which is very interesting comes to my mind. And after all the work finished, I have better understanding of this method.

ACKNOWLEDGEMENTS

Thanks for the huge help from Dr. Jeff Houlahan because of his patience, thoughtful teaching ways and timely feedbacks. Also, thanks for a lot of useful information from Dr. Christopher Gray because we had many matched classes that providing useful feedbacks for my work. Finally, I would like to thank for the Canadian River Institute provided the code and any information collecting support from UNBSJ library.

STATEMENT OF RESEARCH CONTRIBUTION

Dr. Jeff Houlahan and I designed the research. We chose five marine ecology journals from which to extract articles. I selected two articles per year for 10 years from 2009 to 2018 with the objective of getting at least 100 papers. After selecting all the articles that I used, I extracted all the necessary data from each paper and estimated optimal α for each test we use from each article. Then I used optimal α method to analyze the data to make conclusions and compared what we concluded using optimal alpha with what was concluded using NHST. Last, I wrote the first draft of the thesis and write the final version with Dr. Houlahan's help.

TIMELINE OF THE PROJECT

Time	Task
September (1^{st} - 8^{th})	select 5 journals
October 1^{st} - December 6^{th}	finish writing introduction and method part of the thesis
September 1^{st} - January 31^{st}	choose at least 100 articles with certain type of test, extract the data
February (1^{st} - 21^{st})	use code to estimate optimal alpha for each paper and make conclusion, compare the different conclusions
March 13^{th}	finish writing thesis

Table of contents

List of Tables

List of Figures

List of Symbols, Nomenclature or Abbreviations

Null hypothesis statistical testing (NHST)

Critical effect size (CES)

Effect size (ES)

Type I error (α)

Type II error (β)

Average of Type I and Type II error (ω)

Analysis of variance (ANOVA)

Optimal alpha at small effect size (SOA)

Optimal alpha at medium effect size (MOA)

Optimal alpha at large effect size (LOA)

Introduction

Traditional null hypothesis statistical testing (NHST) is widely used across many disciplines including ecology (Anderson, Burnham, & Thompson, 2000), health science (Silva-Ayçaguer, Suárez-Gil, & Fernández-Somoano, 2010), and econometrics (Romano, Shaikh, & Wolf, 2010). Traditional NHST estimates a p-value, which is the probability of observing data as extreme or more extreme than what was observed if the null hypothesis were true. After estimating a p-value, that value is compared to a threshold and if the p-value is less than the threshold, we reject the null hypothesis. If not, we fail to reject the null hypothesis. Thus, the p-value acts as a decision-making tool to indicate the most suitable conclusion and at the same time, it can control the long run probability of making a Type I error (Weiss, 2016).

Scientists began using p-values as a part of modern statistics because of Fisher and Neyman-Pearson's research from 1915 to 1933. Fisher and Neyman-Pearson had two very different philosophies about how to use p-values. Fisher used p-values to make inductive inferences, that is, make general conclusions from specific observations. Fisher did not emphasize using p-values to make decisions. However, Neyman-Pearson emphasized using p-values to make decisions and control the long run probability of making a Type I error. Fisher's philosophy paid little attention to the significance level, but Neyman-Pearson's philosophy always used a constant fixed significance level. Also, Fisher did not consider Type II error and power while Neyman-Pearson emphasize the importance of having an alternative hypothesis and estimating power. The third distinction between the two philosophies is Fisher did not discuss prior probabilities of the null or alternative hypothesis while Neyman-Pearson did discuss the importance of prior probabilities (Lehmann, 1993).

Despite the widespread use of NHST, many papers have been published describing the shortcomings of this method. Four distinct problems that come from NHST were suggested. First, when researchers use NHST, they ignore the probability of making a Type II error (failing to reject the null hypothesis when the null hypothesis is false). Second, effect size is ignored. The p-value tells us nothing about how large the observed effect size is. Third, p-values are very sensitive to sample size. All other things being equal, the bigger the sample size, the smaller the p-value will be. If we have very small sample sizes, even very large effect sizes will be very difficult to detect due to low power. On the other hand, if we have huge sample sizes, we may detect even tiny effect sizes. So, that when we have small sample sizes, we may miss large effects that are important and when we have large sample sizes, we may find statistically significant effects that are not important. Last, p-values don't tell us what we want them to. We wish that p-values would tell us the probability of making a mistake when we reject or fail to reject the null – unfortunately, it cannot estimate the probability that a researcher is making a mistake. This is because p-values are conditional probabilities. The observed p-value is always conditional on the null hypothesis being true. Because we rarely know the probability that the null hypothesis is true, the p-value doesn't tell us the probability of making an error (Johnson, 1999; Mudge, Baker, Edge, & Houlahan, 2012).

Optimal α method was introduced to address some of the problems associated with NHST. The objective of optimal α is to choose the rejection threshold so as to minimize the probability of making either Type I or Type II errors when we reject or fail to reject the null hypothesis. We can do this because, there is always a negative nonlinear relationship between Type I and II error probabilities. That is, when we increase the chance of making a Type I error, we decrease the chance of making a Type II error and vice-versa (Figure 1).

Type II error probabilities are a function of (1) the type of test, (2) the effect size we want to detect, (3) the sample size of the study, and (4) alpha. Therefore. for a specific test, sample size and critical effect size, there is always a specific relationship between α and β. This means for each α, there is a single corresponding β. So, for each α, there must also be a single 'overall' probability of making an error (α+β)/2 and we can plot this relationship between α and (α + β)/2 (Figure 2). To minimize the 'overall' probability of making an error, the lowest point of this curve can be found (Figure 2), and the corresponding α value is the threshold that should be used to reject or fail to reject the null hypothesis (Mudge, Baker, Edge, & Houlahan, 2012).

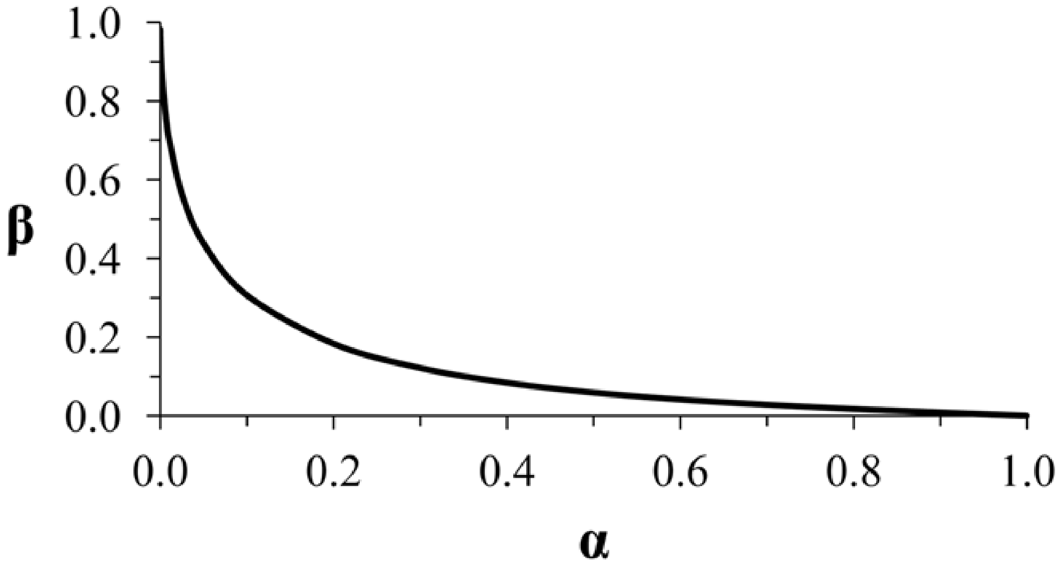


Figure 1. The non-linear relationship between a and b. The relationship between α and β for an independent 2-sample, 2-tailed t test with n1=n2 = 10, and critical effect size = 1 s. *doi:10.1371/journal.pone.0032734.g001*

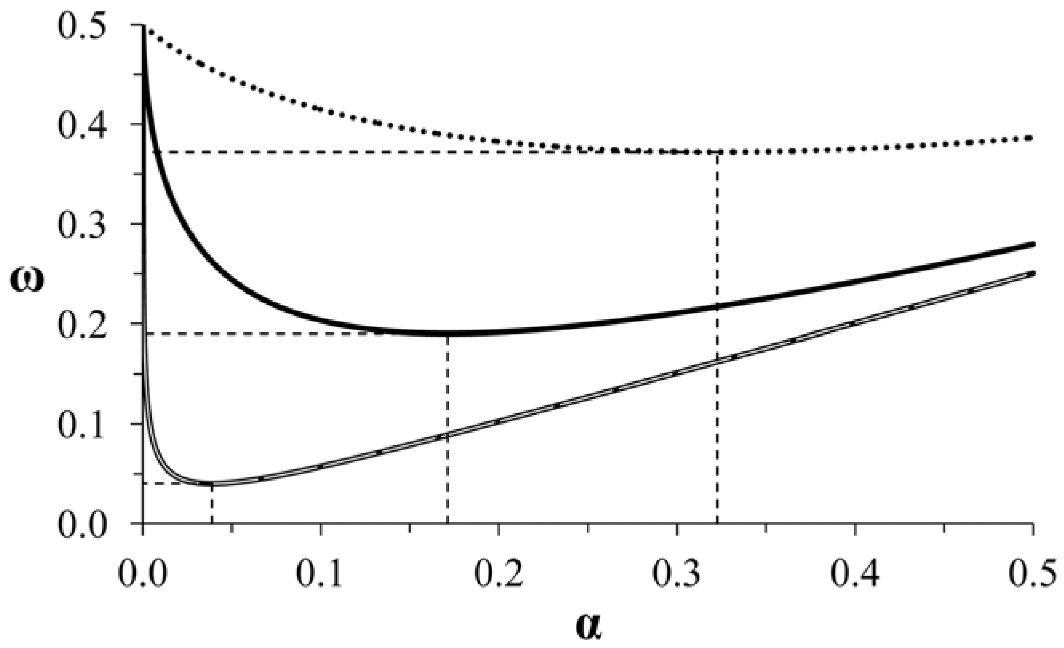


Figure 2. Determination of optimal α from the a priori combined probabilities of Type I and Type II error. α and ω (the average of Type I and Type II error) for independent, 2-tailed, 2-sample t-tests (n1=n2). Data are for 3 (dotted line), 10 (solid line), and 30 (double line) samples per group, with critical effect sizes of 1 SD of either group. Drop lines indicate the minimum average of Type I and Type II error and its associated value of α. *doi:10.1371/journal.pone.0032734.g002*

Optimal α addresses the four main problems with NHST described above. First, optimal α considers type II error and effect size. For optimal α, we must estimate type II error if we want to calculate (α+β)/2. This is because we must identify the type II error probability that is associated with each α. To do that we have to identify and define a critical effect size that is large enough for researchers to care about. The shape of the curve will be different for different critical effect sizes, and optimal α will also be different for different critical effect sizes. For example, using a t test, the curve is defined by (1) sample size in each of the groups and (2) the effect size that we want to detect. If we change either of those, the curve will change. Unlike traditional NHST where the rejection threshold does not change with sample size, with optimal α, if sample size changes so does the rejection threshold. P-values are very sensitive to the sample size but optimal α accounts for that while traditional

NHST does not. P-value are conditional probabilities. That is, they estimate the probability of rejecting the null hypothesis if the null hypothesis is true. But we cannot estimate the probability that a type I error is being made in a particular case without knowing the prior probability that the null hypothesis is true. Traditional NHST ignores prior probabilities so, while we know the probability of making a Type I error if the null is true, we don't know the probability of making a Type I error in a particular case because we don't consider the prior probability of the null being true. Optimal α assumes the prior probabilities of the null and alternative hypotheses are equal (i. e. 50%). Thus, optimal α probabilities are estimates of the probability of making an error (Mudge, Baker, Edge, & Houlahan, 2012).

Optimal α method is a better approach to setting the rejection threshold for statistical tests, but it is still not very clear how often using optimal α would lead to different conclusions than NHST. If the two approaches would rarely lead to different conclusions the effort required to calculate optimal α may not be warranted. I will extract data from 144 marine ecology journal articles, 433 tests and estimate how often we would reach different conclusions if we used optimal α instead of traditional NHST.

Methods

Optimal alpha

Optimal α is a statistical method designed to set the rejection threshold so as to minimize the probability of making either type I (i.e. α) and type II (i.e. β) errors when researchers reject or fail to reject the null hypothesis. To do this we identify the rejection threshold (i.e. optimal α) corresponding to the smallest value of (α plus β)/2. Thus, we must specify the relationship between α and β. Type II errors rely on four factors: test type; sample size, critical effect size and α value. So, for any test and sample size, we must define the critical effect size.

Effect size and critical effect size

The effect size describes how much one variable affects another. The Critical effect size (CES) is the effect size that researchers decide is large enough to be important. Of course, this is subjective. For example, when people want to decide if the paper-making industry pollution affects the density of fish population in a lake, different people would likely identify different critical effect sizes. For the fishermen, maybe 1% reduction on the density is not important, while a 5% decline would be big enough to care about. For the industry owner, a 10 % reduction might still not be considered important and only a reduction to 50 % less density should be considered a problem. An environmental activist might consider a 1 % decrease to be serious for the ecosystem of the lake. Therefore, critical effect size is subjective and there will rarely be an objective answer.

Because of the difficulty of identifying an objective critical effect size, I have selected an effect size range including three effect sizes, large, small and intermediate effects. The precise magnitude of these effect sizes depends on the test. For a t test, a small CES is defined as 0.2, which means the difference between groups relatives to the difference within groups is 0.2 (i.e. 0.2 SD). The medium and large critical effect sizes are 0.5 and 1.0 SD’s respectively. For ANOVA, small, medium and large CES are 0.04, 0.25 and 0.65, respectively. For regression and correlation, CES values are defined as 0.2, 0.5, 0.8 and for chi square, standards are 0.1, 0.3, 0.5. For each of these three effect sizes, there will be a different optimal α value.

Marine biology journals

I chose five marine ecology journals: ICES Journal of Marine Science; Frontiers in Marine Science; Marine Ecology Progress Series; Marine Environmental Research; Journal of Experimental Marine Biology and Ecology. These journals are highly cited, authoritative marine biology sources. I selected at least two articles per publication year from 2009 to 2018 from each journal except journal Frontiers in Marine Science. For this journal, I am only able to find one article in some years, so I select three articles from another year. Totally I have 15 papers in this journal. Overall, I accumulate 144 papers and 433 tests. I am able to calculate optimal α for t test, regression, correlation, ANOVA, and chi square so, only articles using these tests were selected. There are 40 t test, 127 regression and correlation, 237 ANOVA, and 29 chi square. Data required to calculate optimal α and compare to traditional NHST were found and extracted from all articles.

Data Extraction

For all tests, we must extract the observed p-value for each test. However, the additional required information varies among tests.

1) t test

T-tests - two sample, one sample and paired tests - compare two means. Here, the independent variable is categorical and dependent variable is continuous. Only sample size must be extracted for t tests.

2) ANOVA

For ANOVA's (Analysis of variance), more than two means are compared in the sample. For ANOVA's, as for t-tests, the independent variable is categorical and dependent variable is continuous. We extract the degrees of freedom associated with a test. The degrees of freedom (i.e. u and v) u is the number of groups minus 1 and v is the total number of observations minus the number of groups.

3) regression/correlation

These are two methods to analyze the association between variables. Regression implies there is a direct cause and effect relationship between the independent and dependent variable and correlation does not. Further, for regression there can be more than one independent variable. In these methods, we only need sample size to calculate optimal α value.

4) chi square

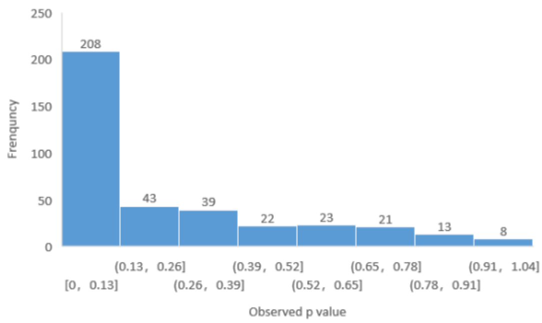
This method compares observed frequency in two or more groups with the expected frequency. Also, it can test the independence between two variables. Variables we consider in this method are categorical. We extract sample size and degree of freedom in this method. Degree of freedom is (r-1) (c-1), where r and c are the number of categories minus 1 for each of the two variables under consideration.

How to compare the results between optimal α and traditional NHST

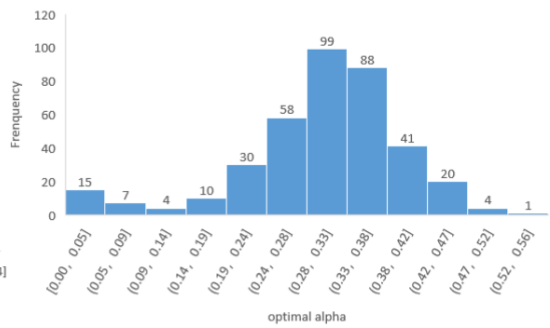
I can calculate optimal α values for tests that have already been published and then compare them with observed p-values to determine whether to reject or not reject the null hypotheses - if the test statistic is less than the threshold, we reject and if it is larger than or equal to the threshold we fail to reject the null hypothesis. Thus, the threshold is necessary to reach a conclusion about whether or not there is support for the null hypothesis. If the thresholds differ between optimal alpha and NHST different conclusions may be reached. After doing this for all tests, I can estimate how often I reach different conclusions using optimal α rather than using traditional NHST. We have decided to consider anything below 5 % to be unimportant, 5%-25% to be moderately important, and greater than 50% to be very important. These are subjective categories.

Results

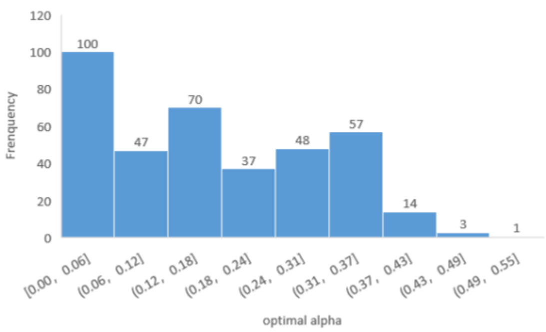
Summary: I extracted data from 144 papers using t tests, ANOVA, regression/correlation or chi square. Some papers included multiple tests so, an optimal alpha and NHST thresholds were compared for a total of 433 tests. Most observed p values lie between 0.05 to 0.30 with an average observed p value of 0.22 and a median of 0.09. Most optimal alphas were between 0.28 and 0.38, 0 and 0.18 and 0 and 0.05 for small, medium and large effect sizes, respectively. Small effect size has a mean and median value 0.30, medium effect size has a mean value 0.17, median value 0.15 and large effect size has a mean 0.09, median 0.034 (Figure 3a-d).



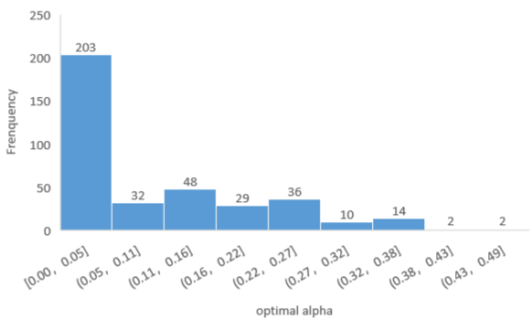
(a)



(b)



(c)



(d)

Figure 3. The distribution of (a) observed p value among all four tests and the distribution of optimal alpha in (b) small effect size (c) medium effect size (d) large

effect size. (N=377).

Disagreement/agreement for small, medium and large effect sizes.

Optimal alpha and NHST reached different conclusions in 24% of tests across all effect sizes. However, for small and medium effects sizes there were disagreements in 22% of tests and for large effect sizes the disagreement reached 29 % (Figure 4).

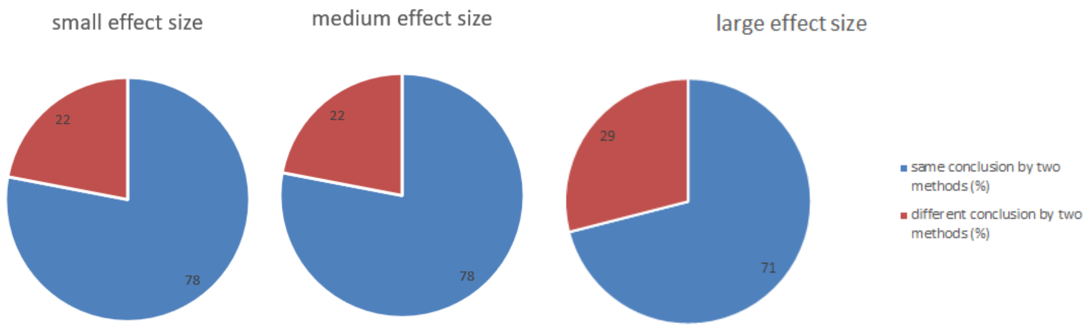


Figure 4. The proportion of same or different conclusion made by NHST and optimal alpha using small, medium and large CES (N=433).

Direction of disagreement.

When there is disagreement, it may be that optimal alpha rejects the null and NHST fails to reject or vice-versa. The percentage of disagreement when optimal alpha getting rejects the null and NHST fails to reject declines as the effect size increases. So, NHST is more likely to have significant conclusion at large effect size and optimal alpha at small effect sizes with medium effect size being intermediate (Figure 5).

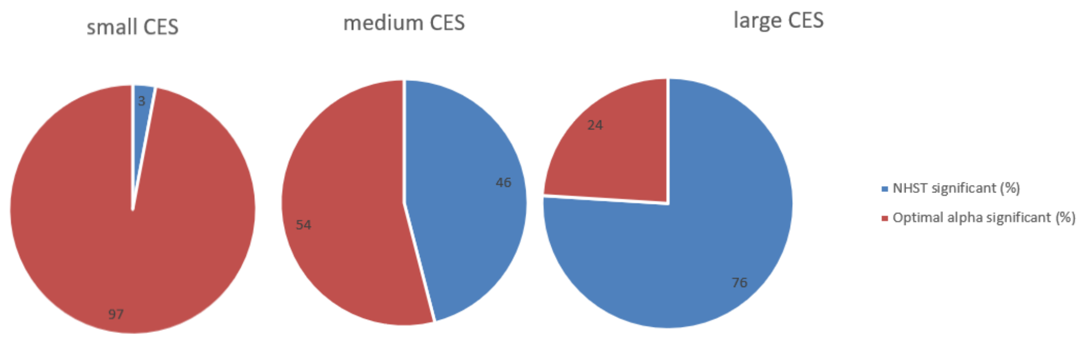
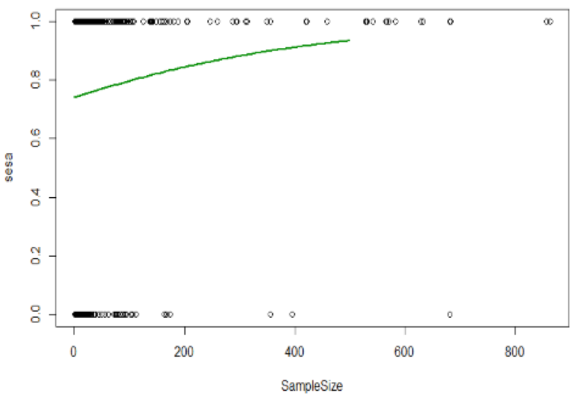


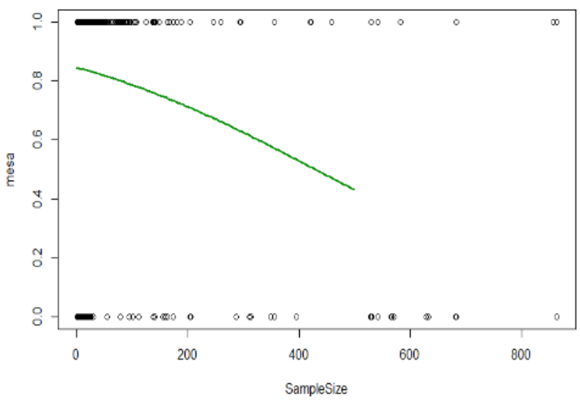
Figure 5. The percentage of disagreement for NHST and Optimal alpha method getting significant conclusion when use small, medium and large CES (N= 95, 94,125).

Sample size and disagreement/agreement.

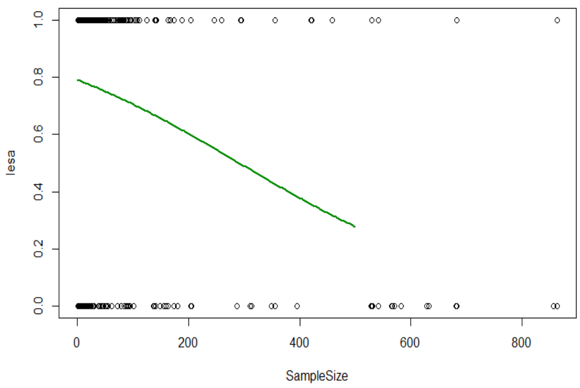
There is a reduced probability of agreement at small sample size for small effects but reduced probability of agreement at large sample sizes for medium and large effects (Figure 6a-c). Sesa represents the disagreement (0) or agreement (1) at small effect size, mesa represents that at medium effect size and lesa represents that at large effect size.



(a) Sesa=0.0032*SampleSize+1.0431



(b) Mesa=-0.0040*SampleSize + 1.6982

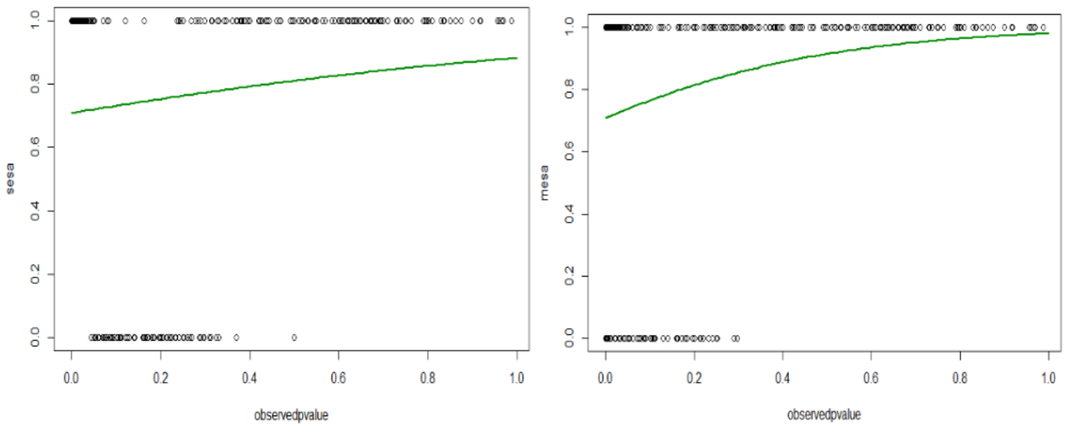


(c) Lesa=-0.0046*SampleSize+ 1.3317

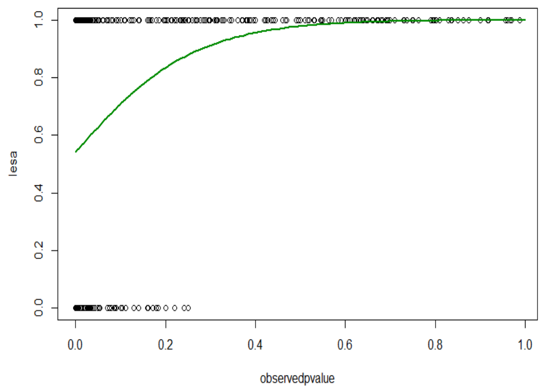
Figure 6. Relationship between sample size and agreement or disagreement when use different effect size, (a) small effect size, p=0.0114 (b) medium effect size, p= 2.03e-08 (c) large effect size, p=8.42e-09. Using logistic regression model, fitted line is showed in the graph (N=431).

Observed p value and disagreement/agreement.

For all effect sizes the probability of agreement was reduced when observed p-values were small but, this pattern was more pronounced for large effect sizes (Figure 7a-c).



(a)Sesa=1.1256*observed pvalue + 0.8868 (b)Mesa=2.9618* observed pvalue + 0.8799

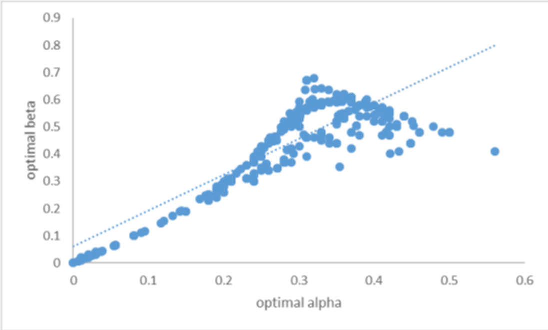


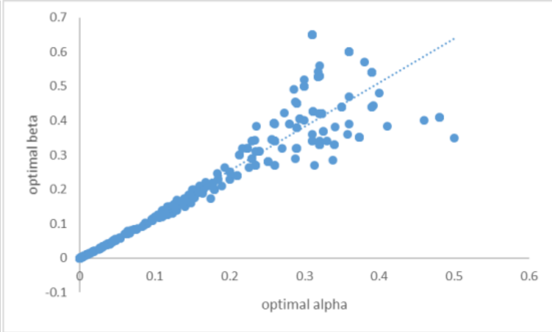
(c) Lesa= 7.2779*observed pvalue+ 0.1601

Figure 7. Relationship between observed p value and agreement or disagreement when use different effect size, (a) small effect size, p= 0.0252 (b) medium effect size, p=0.0000571(c) large effect size, p=6.76e-09. Using logistic regression model, fitted line is showed in the graph (N=377).

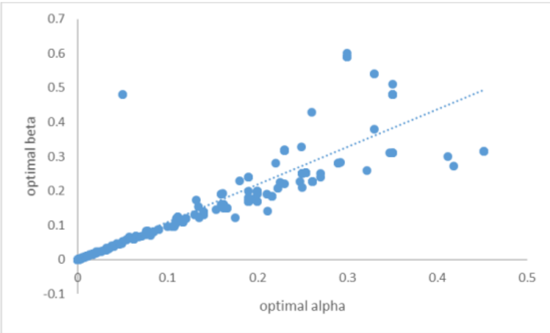
Optimal alpha, optimal beta and overall error probability.

There is a nonlinear relationship between optimal alpha and optimal beta for all three effect sizes (Figure 8a-c) but there is a relative linear relationship between optimal alpha and overall probability of error (Figure 9a-c). The relationship becomes much noisier as optimal alpha increases for all effect sizes. There appears to be a hard ceiling on the overall probability of error of 0.5 (Figure 9a-c).



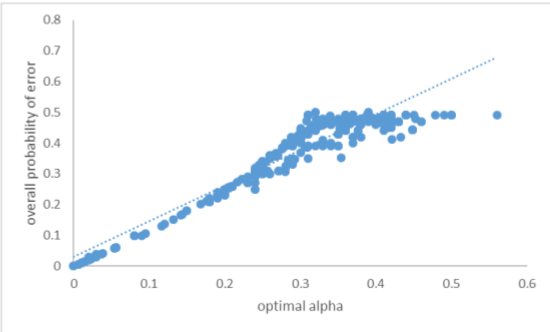


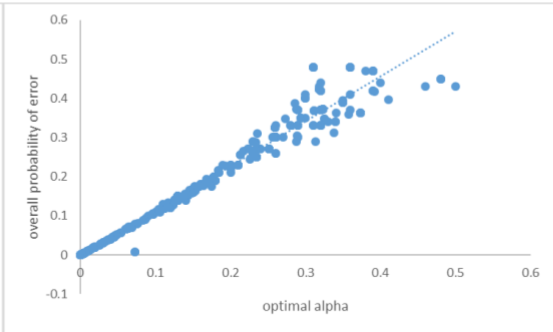
(a) (b)



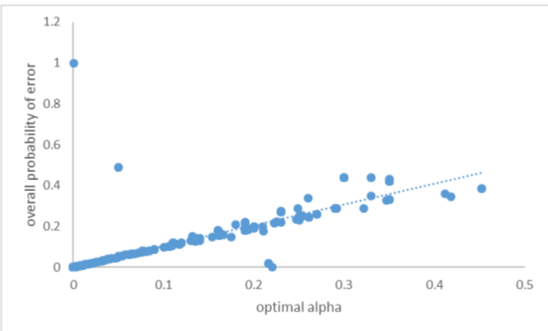
(c)

Figure 8. Relationship between optimal alpha and optimal beta when use (a) small, (b) medium and (c) large effect size (N=433).





(a) (b)



(c)

Figure 9. Relationship between optimal alpha and overall probability of error (a) small, (b) medium and (c) large effect size (N=433).

Sample size and optimal alpha.

There is a nonlinear, negative relationship between sample size and optimal alpha for all effect sizes though the relationship is much noisier for small and medium effects than large effects. (Figure 10).

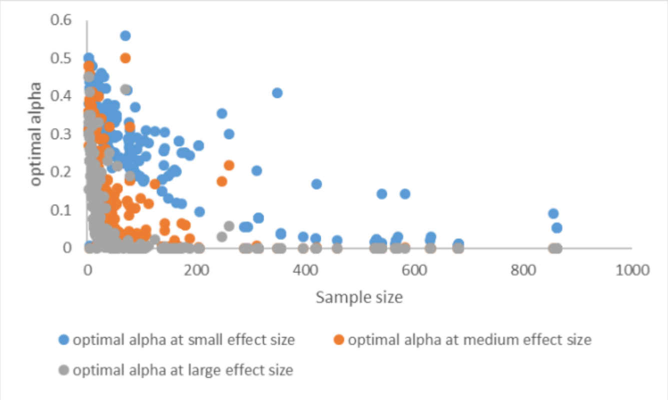


Figure 10. Relationships between sample size and optimal alpha when use small, medium and large effect size (N=431).

Discussion

There are five key findings from the results. First is that in more than a quarter of all tests, optimal alpha method leads to a different conclusion than traditional NHST. The overall probability of disagreement between two methods in terms of all replicates is 24 %, which is considered moderately important because lie in the range from 5 % to 25 %. The disagreement at small effect size is 22 %, the same as medium effect size and the probability of disagreement at large effect size is 29 %. Second, the type of disagreement varies with critical effect size - for small effect size, the probability of optimal alpha rejecting the null when NHST fails to reject is four times bigger than in large effect size while the probability of optimal alpha failing to reject when NHST rejects is four times as high for large critical effect sizes. For medium critical effect size the type of disagreement is more evenly split. Third, larger sample sizes lead to the lower optimal alpha, but the relationship is more dramatic for medium and large critical effect size. Fourth, sample size affects the probability of agreement, disagreement at small, medium and large effect size. Lastly, for all effect sizes when the observed p value is low, it is more likely to have disagreement.

When we attempt to detect small effect sizes, we will usually have low power, and high beta. Because, we are balancing Type I and II errors this will often result in high optimal alpha values. The average optimal alpha for small critical effect sizes is quite large implying that these marine ecology studies were rarely well-designed to detect small effect sizes. Generally, when we attempt to detect large effect size, we will have high power and low beta. So, we have low optimal alpha. Thus, the experimental design of these studies is often appropriate for detecting large but not small effects. There is a significant relationship between sample size and agreement or disagreement in all effect size. It means larger sample size is more likely to have agreement when detecting small effect size. When detecting medium and large effect size, larger sample size is more likely to have disagreed conclusions because we would generally reduce the statistical threshold and thus, reduce the overall probability of error. So, optimal alpha is an indicator of the quality of experimental design and large critical effect sizes and large sample sizes always reduce optimal alpha and improve experimental design.

In the last few decades, statisticians point out some problems of NHST. First, when researchers perform research, they treat statistical significance as more important than biological significance, i.e. they ignore the effect size. We could have statistically significant difference, but it doesn’t necessarily matter in any real situations. A biological significant difference is the difference that really matters in real ways. Second, researchers often ignore type II error, which is false negative: fail to reject the null when null is false. Ignoring type II error could cause serious problems. For example, failing to detect the negative side effects of new drugs could lead to unproper treatment. Failing to detect pollution in a river caused by paper-making farm could lead to worse river ecosystem. Third, p values don't tell us what we want them to. P values are conditional probabilities. We wish p value could give us the probability the null is true (probability of making mistakes) for a given dataset, but p values only tell us the probability of making a mistake if the null hypothesis is true (Cohen, 1994 & Gliner et al., 2002). Optimal alpha addresses all these problems.

Because of the concern of NHST problems, several influential statisticians propose discontinuing the use of NHST. It has been suggested that unless we have to use p values to make decisions, we should not use p values and should not support the idea of "statistical significance". Instead, we should be very doubtful for significant results when use 0.05 threshold. Second, it has been suggested that we should mention p values when we analyze and interpret data in some cases, but not use p values as a decision-making tool. Third, we should explain p value in terms of its sample size and useful effect size and then combine those variables with p value to make decisions about whether or not reject the hypothesis. Fourth, use p value to make fundamental inference by incorporating other method and embed NHST in a prior background. Fifth, choose more appropriate thresholds and interpret p-values as suggestive rather than definitive. There have been more extreme suggestions, such as, using likelihood rations for competing hypotheses instead of any form of null hypothesis testing or not mentioning statistically significance and use other indicators such as false positive risk (Wasserstein et al., 2019).

In psychology and other areas, reproducibility crisis has been revealed in the last few years. Reproducibility crisis refers to scientists replicating previous research but failing to find similar results that would lead to the same conclusion (Maxwell et al., 2015). A review paper of reproducibility crisis discusses a lot of other articles related to this concept. In "The Open Science Collaboration's Reproducibility Project", 356 participants from 41 institutions redid 100 experiments, compared p values and effect size and made subjective assessments to compare results. In only 36 % of duplicated experiments did both studies achieve statistical significance and in only 47 % of studies did the effect size lie in the duplicated study lie inside the 95 % confident interval from the original study. Researchers subjectively estimate 39 % of the results are the same as original results. In another article called "Why Most Published Research Findings Are False", author proposed we cannot get 100 % certainty in correct research results because the false bias in research design, analysis, report and type I error in publishing. Among 1,576 researchers, over 70 % have attempted and failed to replicate other researchers' experiments. This implies a reproducibility crisis and concern has arisen about the reliability of historical research (Sayre & Riegelman, 2018). The reason for this crisis happening partially is that past studies used NHST with all the associated problems. Where Type I or Type II errors are made in an earlier study it is unlikely that the results can be reproduced (Maxwell et al., 2015).

However, statisticians may be hasty in suggesting the elimination of NHST, because optimal alpha can solve many of the problems associated with NHST. Optimal alpha is a better way than NHST. Using optimal alpha would reduce the frequency of Type I and Type II errors and reduce the frequency that we don't get the same result when experiments are repeated. Any method that allows us to reduce Type I and II errors will allow us to avoid believing things are true that aren't and not being aware of true explanations for how the world works.

All the problems are associate with NHST may also be true in marine ecology. I looked in marine ecology papers and found that optimal alpha and NHST would reach different conclusions in more than 24% of tests, which means there is a real negative effect of using NHST in marine ecology. We can use optimal alpha to help solve this 24 % mistake problem from NHST by minimizing the overall probability of making mistakes. In addition, we know one contributor to reproducibility crisis is caused by the problems associate with NHST. Maybe marine ecology also has a problem with reproducibility but is just currently unaware of it. This is something that needs further research. According to a previous research in ecology, author find 22 % disagreement at small effect size, 20 % at medium effect size and 25 % at large effect size. That is partly consistent to my result but with a little difference. Also, that paper finds bigger effect size will have smaller optimal alpha value, which is similar to my result (Aidemouni, 2019).

My study only investigated five marine ecology journals and only included publications from 2009 to 2018. Only two papers were chosen per year. We had hoped to have same number of papers from each of the ten years, but we were not able to do that for all journals. So, it is a relatively small size and may not be representative of what is happening in marine ecology, at large. It is also particular to marine ecology and my results may not apply to ecology, in general. Similarly, what occurred between 2009 and 2018 may not represent what will happen in the future. Therefore, we can broad the researching area to all ecology and have more journals, years, and papers. We only have code for a small subset of tests used by marine ecologists. It may be that a wider application of optimal alpha to a great range of analytical techniques might produce different results. The next steps include developing code for more tests.

References

Aidemouni, M. (2019). *Optimal alpha – Is the traditional statistical threshold (α = 0.05) for Null Hypothesis Significance Testing a problem?* (Unpublished bachelor's dissertation). The university of New Brunswick, Saint John, New Brunswick.

Anderson, D. R., Burnham, K. P., & Thompson, W. L. (2000). Null Hypothesis Testing: Problems, Prevalence, and an Alternative. *The Journal of Wildlife Management*, *64*(4), 912–923.

Cohen, J. (1994). The Earth is round (p < .05). American Psychologist, 49(12), 997–1003.

Gliner, J. A., Leech, N. L., & Morgan, G. A. (2002). Problems with null hypothesis significance testing (NHST): What do the textbooks say? The Journal of Experimental Education, 71(1), 83–92.

Johnson, D. H. (1999). The Insignificance of Statistical Significance Testing. *The Journal of Wildlife Management*, *63*(3), 763–772.

Lehmann, E. L. (1993). The Fisher, Neyman-Pearson Theories of Testing Hypotheses: One Theory or Two? *Journal of the American Statistical Association*, *88*(424), 1242–1249.

Maxwell, S. E., Lau, M. Y., & Howard, G. S. (2015). Is psychology suffering from a replication crisis? What does “failure to replicate” really mean? American Psychologist, 70(6), 487–498.

Mudge, J. F., Baker, L. F., Edge, C. B., & Houlahan, J. E. (2012). Setting an Optimal α That Minimizes Errors in Null Hypothesis Significance Tests. *PLOS ONE*, *7*(2), e32734.

Romano, J. P., Shaikh, A. M., & Wolf, M. (2010). Hypothesis Testing in Econometrics. *Annual Review of Economics*, *2*(1), 75–104.

Sayre, F., & Riegelman, A. (2018). The reproducibility crisis and academic libraries. College & Research Libraries, 79(1), 2–9.

Silva-Ayçaguer, L. C., Suárez-Gil, P., & Fernández-Somoano, A. (2010). The null hypothesis significance test in health sciences research (1995-2006): Statistical analysis and interpretation. *BMC Medical Research Methodology*, *10*, 44.

Wasserstein, R. L., Schirm, A. L., & Lazar, N. A. (2019). Moving to a world beyond "p < 0.05." The American Statistician, 73(sup1), 1–19.

Weiss, N.A. (2016). Introductory Statistics. 10th Edition. Pearson. Pp.331-741

Appendix I

Table 1. Extracted data including test type, sample size, u, v, df, observed p value, year and if it is significant at 0.05 level.

Type of Test (ANOVA, t test, correlation, regression, chi-square, logistic regression	N		N1	N2	two-sample,one-sample, paired	one-tailed,two tailed	u	v	df	observed p-value	year	significant? (<0.05)
ANOVA	6						1	4		0.044	2018	sig
ANOVA	6						1	4		0.022	2018	sig
ANOVA	6						1	4		0.44	2018	nonsig
ANOVA	6						1	4		0.075	2018	nonsig
ANOVA	5						1	3		0.22	2018	nonsig
ANOVA	5						1	3		0.079	2018	nonsig
ANOVA	96						1	94		0.283	2018	nonsig
ANOVA	356						1	354		0.043	2018	sig
correlation	356									0.53	2018	nonsig
correlation	356									0.006	2018	sig
ANOVA	38						2	35		0.041	2018	sig
ANOVA	38						2	35		0.009	2018	sig
ANOVA	38						2	35		0.467	2018	nonsig
ANOVA	37						5	31		<0.001	2018	sig

ANOVA	22						2	19		0.917	2018	nonsig
chi square	6								5	0.002	2018	sig
chi square	6								5	0.004	2018	sig
chi square	6								5	0.002	2018	sig
chi square	6								5	0.242	2018	nonsig
chi square	3								2	0.004	2018	sig
chi square	3								2	0.001	2018	sig
chi square	2								1	0.242	2018	nonsig
chi square	2								1	<0.001	2018	sig
chi square	3								2	0.395	2018	nonsig
chi square	3								2	0.444	2018	nonsig
chi square	3								2	0.386	2018	nonsig
chi square	3								2	0.38	2018	nonsig
chi square	21								20	<=0.001	2018	sig
regression	88									0.06	2018	nonsig
correlation	38									<0.001	2018	sig
correlation	38									<0.001	2018	sig
ANOVA	79						2	76		0.299	2017	nonsig
ANOVA	70						64	5		0.002	2017	sig
correlation	396									<0.05	2017	sig
regression	16									<0.01	2017	sig
ANOVA	528						1	526		<0.001	2017	sig
ANOVA	88						1	86		<0.002	2017	sig
ANOVA	45						2	42		0.233	2017	nonsig
t test	8				one sample	two-tailed				0.214	2017	nonsig
t test	8				one sample	two-tailed				0.918	2017	nonsig

ANOVA	12						1	10		0.004	2017	sig
ANOVA	14						3	10		<0.001	2017	sig
ANOVA	14						3	10		0.297	2017	nonsig
ANOVA	15						4	10		0.297	2017	nonsig
correlation	46									<0.001	2016	sig
correlation	23									<0.001	2016	sig
correlation	23								3	0.001	2016	sig
correlation	43									0.002	2016	sig
correlation	46									<0.001	2016	sig
correlation	46									0.02	2016	sig
correlation	39									0.004	2016	sig
correlation	8									<0.001	2016	sig
correlation	5									0.7	2016	nonsig
correlation	5									0.03	2016	sig
correlation	85									<0.001	2016	sig
correlation	7									<0.001	2016	sig
chi square	4								3	<0.0001	2016	sig
ANOVA	10						1	8		0.002	2016	sig
ANOVA	8						1	6		0.0149	2016	sig
ANOVA	8						1	6		0.1398	2016	nonsig
ANOVA	149						3	145		0.001	2016	sig
ANOVA	683						3	679		0.07	2016	nonsig
ANOVA	632						5	626		< 0.0001	2016	sig
ANOVA	570						5	564		< 0.0001	2016	sig
ANOVA	683						3	679		<0.0001	2016	sig
ANOVA	681						1	679		<0.05	2016	sig

ANOVA	683						3	679		<0.0001	2016	sig
ANOVA	681						1	679		<0.0001	2016	sig
ANOVA	683						3	679		<0.0001	2016	sig
ANOVA	314						3	310		<0.01	2016	sig
ANOVA	314						3	310		<0.01	2016	sig
ANOVA	314						3	310		<0.0001	2016	sig
ANOVA	314						3	310		<0.0001	2016	sig
ANOVA	629						3	625		<0.01	2016	sig
ANOVA	567						3	563		<0.01	2016	sig
ANOVA	565						1	563		<0.0001	2016	sig
ANOVA	567						3	563		<0.0001	2016	sig
chi square	5						1	680		<0.0001	2016	sig
correlation	23									0.009	2016	sig
chi square	2								1	0.343	2016	nonsig
chi square	2								1	0.545	2016	nonsig
chi square	2								1	0.09	2015	nonsig
correlation	21									0.7626	2015	nonsig
correlation	24									0.695163	2015	nonsig
correlation	21									0.737075	2015	nonsig
correlation	24									0.315527	2015	nonsig
correlation	24									0.639086	2015	nonsig
correlation	24									0.671341	2015	nonsig
correlation	24									0.618881	2015	nonsig
correlation	21									0.801328	2015	nonsig
correlation	21									0.682707	2015	nonsig
correlation	24									0.862289	2015	nonsig

correlation	24									0.26582	2015	nonsig
correlation	24									0.836977	2015	nonsig
correlation	24									0.141011	2015	nonsig
correlation	24									0.315527	2015	nonsig
correlation	7									0.0036	2015	sig
correlation	25									0.0054	2015	sig
correlation	11									<0.001	2015	sig
correlation	56									<0.001	2015	sig
correlation	40									<0.0075	2015	sig
correlation	27									0.05	2014	nonsig
ANOVA	6						1	4		0.55	2014	nonsig
ANOVA	6						1	4		0.33	2014	nonsig
ANOVA	6						1	4		0.97	2014	nonsig
ANOVA	155						4	150		0.03	2014	sig
ANOVA	206						1	204		0.01	2014	sig
ANOVA	174						1	172		0.01	2014	sig
ANOVA	294						1	292		0.08	2014	nonsig
ANOVA	295						1	293		0.12	2014	nonsig
ANOVA	102						1	100		0.01	2014	sig
ANOVA	57						1	55		0.7	2014	nonsig
ANOVA	56						1	54		0.09	2014	nonsig
ANOVA	83						1	81		0.12	2014	nonsig
ANOVA	82						1	80		0.24	2014	nonsig
t test	8		4	4	paired	two-tailed				0.046	2014	sig
regression	7									0.007	2014	sig
regression	5									0.007	2014	sig

regression	5									0.021	2014	sig
regression	6									0.196	2014	nonsig
regression	6									0.005	2014	sig
regression	4									0.37	2014	nonsig
ANOVA	12						1	10		0.0148	2014	sig
ANOVA	12						1	10		0.013	2014	sig
correlation	11									0.043	2014	sig
ANOVA	91							5	85	0.012	2013	sig
correlation	15									0.01	2013	sig
correlation	6									0.01	2013	sig
correlation	56									0.016	2013	sig
correlation	56									0.019	2013	sig
correlation	23									0.005	2013	sig
correlation	23									0.01	2013	sig
correlation	9									0.006	2012	sig
correlation	7									0.07	2012	nonsig
regression	19									0.027	2012	sig
correlation	47									0.002	2012	sig
correlation	46									0.532	2012	nonsig
ANOVA	38						2	34		0.73	2012	nonsig
regression	29									0.03	2012	sig
regression	29									0.03	2012	sig
regression	79									0.02	2012	sig
regression	84									0.13	2012	nonsig
regression	84									0.006	2012	sig
ANOVA	34						4	29		0.013	2012	sig

ANOVA	34						4	29		0.61	2012	nonsig
ANOVA	95						2	92		0.205	2011	nonsig
ANOVA	95						1	93		0.032	2011	sig
ANOVA	95						2	92		0.379	2011	nonsig
ANOVA	92						3	88		0.053	2011	nonsig
ANOVA	95						2	92		0.029	2011	sig
ANOVA	95						2	92		0.546	2011	nonsig
ANOVA	95						1	93		0.02	2011	sig
ANOVA	95						2	92		0.763	2011	nonsig
ANOVA	92						3	88		0.012	2011	sig
correlation	20									0.03	2011	sig
correlation	21									0.02	2011	sig
correlation	26									0.09	2011	nonsig
correlation	459									0.347	2011	nonsig
t test	98		55	43	two sample	two tailed				0.006	2010	sig
correlation	420									0.051	2009	nonsig
correlation	420									0.083	2009	nonsig
correlation	40									0.001	2009	sig
ANOVA	21						1	19		0.00032	2018	sig
ANOVA	41						1	39		0.29	2018	nonsig
ANOVA	30						2	27		0.001	2018	sig
ANOVA	50						4	45		0.2001	2018	nonsig
ANOVA	50						4	45		0.2241	2018	nonsig
ANOVA	50						4	45		0.2001	2018	nonsig
correlation	79						2	76		0.00026	2018	sig
correlation	19									0.22	2018	nonsig

ANOVA	16						1	14		0.16	2018	nonsig
ANOVA	16						1	14		0.33	2018	nonsig
t test	20		10	10	paired	two tailed				0.025	2018	sig
ANOVA	20						3	16		0.016	2017	sig
ANOVA	20						3	16		0.002	2017	sig
ANOVA	20						3	16		0.961	2017	nonsig
ANOVA	20						3	16		0.085	2017	nonsig
ANOVA	6						1	4		0.4	2017	nonsig
ANOVA	6						1	4		0.09	2017	nonsig
ANOVA	6						1	4		0.25	2017	nonsig
ANOVA	10						1	8		0.27	2017	nonsig
ANOVA	10						1	8		0.029	2017	sig
ANOVA	10						1	8		0.004	2017	sig
ANOVA	10						1	8		0.002	2017	sig
ANOVA	16						3	12		0.039	2016	sig
t test	6652		3326	3326	paired	one tailed				0	2016	sig
t test	11		5	6	two sample	two tailed				0.0148	2016	sig
ANOVA	20						3	16		0.213	2015	nonsig
ANOVA	20						3	16		0.03	2015	sig
ANOVA	108						2	72		0.4349	2015	nonsig
ANOVA	10						4	5		0.001	2014	sig
ANOVA	30						9	20		0.201	2014	nonsig
chi square	143								2	0.0008	2014	sig
chi square	105						2	102		0.17	2013	nonsig
chi square	23						2	20		0.51	2013	nonsig

correlation	36									0.09	2013	nonsig
t test	8		4	4	paired	one tailed				0.007	2013	sig
t test	10		5	5	paired	one tailed				0.02	2013	sig
ANOVA	8						1	6		0.324	2012	nonsig
ANOVA	13						4	8		0.674	2012	nonsig
t test	856		428	428	two sample	two tailed				0.0001	2012	sig
t test	14		7	7	paired	one tailed				0.029	2012	sig
ANOVA	20						3	16		0.053	2011	nonsig
ANOVA	20						1	18		0.03	2011	sig
ANOVA	6						1	4		0.37	2011	nonsig
correlation	18									0.011	2011	sig
ANOVA	125						3	121		0.5838	2010	nonsig
ANOVA	18						1	16		0.42	2010	nonsig
ANOVA	18						1	16		0.11	2010	nonsig
ANOVA	20						1	18		0.0016	2009	sig
ANOVA	20						1	18		0.0329	2009	sig
ANOVA	29						2	28		0.66	2009	nonsig
ANOVA	31						2	28		0.68	2009	nonsig
t test	24		18	6	two sample	two tailed				0.08	2014	nonsig
t test	247		15	232	two sample	one tailed				0.0022	2014	sig
ANOVA	10						2	7		0.087	2015	nonsig
ANOVA	10						2	7		0.079	2015	nonsig
ANOVA	4						1	2		0.003	2015	sig

chi square	75								1	0.286	2015	nonsig
regression	25									0.061	2016	nonsig
regression	39									0.0696	2016	nonsig
regression	39									0.1664	2016	nonsig
regression	23									0.65	2016	nonsig
ANOVA	73						12	60		0.309	2016	nonsig
ANOVA	73						12	60		0.02	2016	sig
ANOVA	16						3	12		0.956	2016	nonsig
correlation	30									0.96	2016	nonsig
correlation	164									0.03	2017	sig
correlation	20									0.032	2017	sig
correlation	20									0.041	2017	sig
ANOVA	205						5	199		0.495	2017	nonsig
ANOVA	205						5	199		0.006	2017	sig
ANOVA	205						5	199		0.04	2017	sig
ANOVA	6						1	4		0.623	2017	nonsig
ANOVA	11						2	8		0.014	2017	sig
ANOVA	6						1	4		0.835	2017	nonsig
ANOVA	6						1	4		0.103	2017	nonsig
ANOVA	32						2	29		0.3129	2017	nonsig
ANOVA	20						1	18		0.046	2017	sig
ANOVA	30						1	28		0.009	2017	sig
ANOVA	863						4	858		0.245	2018	nonsig
ANOVA	863						4	858		0.646	2018	nonsig
ANOVA	863						4	858		0.002	2018	sig
correlation	21									0.0107	2018	sig

regression	13									0.0006	2018	sig
regression	13									0.25	2018	nonsig
regression	13									0.0017	2018	sig
t test	160		80	80	paired	two tailed				0.04	2018	sig
chi square	24								1	0.26	2018	nonsig
ANOVA	164						1	162		0.101	2018	nonsig
t test	20		10	10	paired	two tailed				0.382	2018	nonsig
correlation	28									0.037	2017	sig
chi square	2								1	0.629	2017	nonsig
ANOVA	19						2	16		0.019	2016	sig
chi square	541								1	0.237	2016	nonsig
chi square	422								1	0.379	2016	nonsig
t test	583		358	225	two sample	two tailed				0.0014	2015	sig
regression	12									0.034	2015	sig
ANOVA	9						2	6		<0.01	2014	sig
regression	52									0.0021	2014	sig
regression	38									0.0049	2014	sig
regression	38									0.004	2014	sig
regression	38									0.0106	2014	sig
regression	38									0.025	2014	sig
regression	541									0.001	2013	sig
ANOVA	168						4	163		0.36	2013	nonsig
ANOVA	168						4	163		0.07	2013	nonsig
ANOVA	168						4	163		0.13	2013	nonsig
ANOVA	140						1	138		0.39	2013	nonsig
ANOVA	141						2	138		0.83	2013	nonsig

ANOVA	141						2	138		0.01	2013	sig
correlation	36									0.001	2013	sig
t test	24		12	12	paired	two tailed				0.00009	2012	sig
ANOVA	28						2	25		0.2952	2012	nonsig
ANOVA	4						1	2		0.184	2011	nonsig
ANOVA	5						1	3		0.031	2011	sig
ANOVA	35						1	33		0.0014	2010	sig
correlation	36									0.33	2010	nonsig
ANOVA	76						3	72		0.18	2009	nonsig
chi square	311								3	0.01	2009	sig
ANOVA	45						1	43		0.693	2009	nonsig
ANOVA	4						1	2		0.03	2018	sig
ANOVA	13						1	11		0.1	2018	nonsig
ANOVA	349						1	347		0.022	2018	sig
ANOVA	13						1	11		0.517	2018	nonsig
ANOVA	13						1	11		0.69	2018	nonsig
ANOVA	16						4	11		0.001	2018	sig
ANOVA	5						2	2		0.172	2018	nonsig
ANOVA	4						1	2		0.16	2018	nonsig
correlation	288									0.01	2018	sig
ANOVA	62						1	60		0.08	2018	nonsig
ANOVA	62						1	60		0.0027	2018	sig
ANOVA	46						1	44		0.007	2018	sig
ANOVA	46						1	44		0.563	2018	nonsig
ANOVA	3						2	11		0.13	2017	nonsig
ANOVA	45						1	76		0.269	2017	nonsig

ANOVA	83						2	80		0.423	2017	nonsig
t test	112		56	56	paired	one tailed				0.108	2017	nonsig
correlation	35									0.008	2017	sig
ANOVA	18						2	15		0.731	2017	nonsig
ANOVA	18						2	15		0.028	2017	sig
ANOVA	18						2	15		0.007	2017	sig
ANOVA	18						2	15		0.371	2017	nonsig
t test	180		90	90	paired	one tailed				0.027	2017	sig
t test	180		90	90	paired	one tailed				0.041	2017	sig
correlation	149									0.00018	2017	sig
ANOVA	78						2	75		0.967	2017	nonsig
ANOVA	43						3	39		0.0003	2017	sig
ANOVA	16						1	14		0.01	2016	sig
ANOVA	7						1	5		0.2	2016	nonsig
t test	6652		3326	3326	paired	one tailed				0	2016	sig
ANOVA	25						10	14		0.043	2015	sig
ANOVA	25						10	14		0.104	2015	nonsig
ANOVA	81						1	79		0.49	2015	nonsig
ANOVA	81						1	79		0.25	2015	nonsig
ANOVA	73						1	71		0.18	2015	nonsig
ANOVA	19						1	17		0.85	2015	nonsig
ANOVA	79						1	77		0.14	2015	nonsig
ANOVA	79						1	77		0.44	2015	nonsig

ANOVA	79						1	77		0.4	2015	nonsig
ANOVA	79						1	77		0.049	2015	sig
ANOVA	79						1	77		0.01	2015	sig
ANOVA	10						1	8		0.03	2015	sig
ANOVA	105						1	103		0.29	2015	nonsig
ANOVA	105						1	103		0.81	2015	nonsig
ANOVA	531						2	528		0.0042	2015	sig
ANOVA	531						2	528		0.0007	2015	sig
ANOVA	531						2	528		0.0001	2015	sig
ANOVA	530						1	528		0.1621	2015	nonsig
ANOVA	530						1	528		0.011	2015	sig
regression	15									0.0134	2015	sig
ANOVA	51						2	48		0.3277	2015	nonsig
ANOVA	27						1	25		0.6013	2015	nonsig
ANOVA	27						1	25		0.875	2015	nonsig
ANOVA	5						1	3		0.001	2015	sig
ANOVA	16						3	12		0.0025	2015	sig
ANOVA	10						1	8		0.001	2015	sig
ANOVA	10						1	8		0.006	2015	sig
ANOVA	10						1	8		0.9	2015	nonsig
ANOVA	10						1	8		0.49	2015	nonsig
ANOVA	18						5	12		p<0.01	2015	sig
ANOVA	18						5	12		p<0.01	2015	sig
ANOVA	18						5	12		0.22	2015	nonsig
ANOVA	18						5	12		0.03	2015	sig
ANOVA	18						5	12		0.67	2015	nonsig

ANOVA	18						5	12		p<0.01	2015	sig
ANOVA	18						5	12		p<0.01	2015	sig
ANOVA	78						5	72		p<0.0001	2015	sig
ANOVA	76						3	72		p<0.0001	2015	sig
ANOVA	88						15	72		p<0.0001	2015	sig
ANOVA	34						9	24		p<0.00001	2014	sig
ANOVA	34						9	24		p<0.00001	2014	sig
t test	55		22	33	two sample	two tailed				0.1291	2014	nonsig
t test	18		7	11	two sample	two tailed				0.1291	2014	nonsig
t test	55		22	33	two sample	two tailed				0.6619	2014	nonsig
t test	18		7	11	two sample	two tailed				0.2496	2014	nonsig
t test	55		22	33	two sample	two tailed				0.3471	2014	nonsig
t test	18		7	11	two sample	two tailed				0.1619	2014	nonsig
correlation	24									0.5	2014	nonsig
correlation	24									0.42	2014	nonsig
correlation	24									p<0.001	2014	sig
correlation	12									0.71	2014	nonsig
correlation	12									0.27	2014	nonsig
correlation	12									0.68	2014	nonsig
ANOVA	53						5	47		0.0486	2014	sig
ANOVA	49						5	43		0.427	2014	nonsig
t test	38		19	19	paired	two tailed				0.186	2014	nonsig
t test	108		54	54	paired	two tailed				0.794	2014	nonsig
t test	12		6	6	paired	two tailed				0.111	2014	nonsig
t test	12		6	6	paired	two tailed				0.232	2014	nonsig
t test	16		8	8	paired	two tailed				0.18	2014	nonsig

correlation	32									0.27	2013	nonsig
correlation	5									0.14	2013	nonsig
correlation	5									0.29	2013	nonsig
t test	174		87	87	two sample	two tailed				0.073	2013	nonsig
regression	11									0.52	2013	nonsig
regression	66									0.314	2013	nonsig
regression	51									0.62	2013	nonsig
regression	48									0.635	2013	nonsig
chi square	188								1	0.6	2013	nonsig
chi square	143								1	0.29	2013	nonsig
ANOVA	3						1	1		p<0.001	2013	sig
ANOVA	3						1	1		0.499	2013	nonsig
ANOVA	3						1	1		0.988	2013	nonsig
ANOVA	23						1	21		0.002	2013	sig
ANOVA	8						2	5		0.002	2013	sig
ANOVA	8						1	6		0.014	2013	sig
t test	8		4	4	two sample	one tailed				0.03	2012	sig
t test	8		4	4	two sample	one tailed				0.047	2012	sig
t test	8		4	4	two sample	one tailed				0.026	2012	sig
t test	8		4	4	two sample	one tailed				0.02	2012	sig
t test	8		4	4	two sample	one tailed				0.005	2012	sig
ANOVA	21						2	18		0.75	2012	nonsig

ANOVA	21						2	18		0.47	2012	nonsig
ANOVA	21						2	18		0.46	2012	nonsig
ANOVA	21						2	18		0.1	2012	nonsig
ANOVA	20						1	18		0.163	2012	nonsig
ANOVA	20						1	18		0.57	2012	nonsig
ANOVA	21						2	18		0.032	2012	sig
ANOVA	20						1	18		0.64	2012	nonsig
ANOVA	20						1	18		0.55	2012	nonsig
ANOVA	20						1	18		p<0.001	2012	sig
ANOVA	137						1	135		p<0.001	2012	sig
ANOVA	138						2	135		0.02	2012	sig
ANOVA	138						2	135		0.02	2012	sig
ANOVA	137						1	135		p<0.0001	2012	sig
ANOVA	138						2	135		0.002	2012	sig
regression	23									0.001	2012	sig
regression	23									0.009	2012	sig
ANOVA	51						1	49		0.001	2011	sig
ANOVA	51						1	49		0.59	2011	nonsig
t test	76		38	38	paried	two tailed				0.79	2011	nonsig
regression	9									0.798	2010	nonsig
regression	9									0.252	2010	nonsig
regression	27									0.606	2010	nonsig
regression	9									0.054	2010	nonsig
regression	9									0.011	2010	sig
regression	9									0.009	2010	sig
ANOVA	50						2	27		0.018	2010	sig

ANOVA	32						2	29		0.749	2010	nonsig
ANOVA	32						2	29		0.1977	2010	nonsig
ANOVA	53						5	47		p<0.0001	2010	sig
ANOVA	53						5	47		p<0.0001	2010	sig
ANOVA	58						1	56	48	p<0.001	2010	sig
ANOVA	39						1	37	72	p<0.001	2010	sig
ANOVA	39						3	35		p<0.03	2010	sig
t test	260		130	130	two sample	two tailed				0.9	2009	nonsig
correlation	30									0.04	2009	sig
correlation	22									0.08	2009	nonsig
regression	53									0.277	2009	nonsig
regression	103									0.094	2009	nonsig
regression	45									0.034	2009	sig
regression	37									0.125	2009	nonsig

Appendix II

Table 2. The optimal alpha, optimal beta, overall probability of error, whether it is significant or not and the comparison result with NHST (Agreement=1, Disagreement=0) at small, medium and large effect size.

optimal.alpha	optimal.beta	overall probability of error	small sig?	medium effect size	optimal.alpha	optimal.beta	overall probability of error	medium sig?	large effect size	optimal.alpha	optimal.beta	overall probability of error	large sig?		sesa	mesa	lesa
0.37	0.59	0.48	sig		0.32	0.42	0.37	sig		0.25	0.25	0.25	sig		1	1	1
0.37	0.59	0.48	sig		0.32	0.42	0.37	sig		0.25	0.25	0.25	sig		1	1	1
0.37	0.59	0.48	non sig		0.32	0.42	0.37	non sig		0.25	0.25	0.25	non sig		1	1	1
0.37	0.59	0.48	sig		0.32	0.42	0.37	sig		0.25	0.25	0.25	sig		0	0	0
0.38	0.58	0.48	sig		0.35	0.44	0.39	sig		0.29	0.28	0.29	sig		0	0	0
0.38	0.58	0.48	sig		0.35	0.44	0.39	sig		0.29	0.28	0.29	sig		0	0	0
0.19	0.26	0.23	non sig		0.011	0.011	0.011	non sig		0.000113	0.0001	0.000107	non sig		1	1	1
0.039	0.045	0.042	non sig		2.47E-06	2.39E-06	2.43E-06	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		0	0	0
0.037	0.042	0.04	non sig		1.85E-07	1.86E-07	1.85E-07	non sig		4.23E-13	0	2.12E-13	non sig		1	1	1
0.037	0.042	0.04	sig		1.85E-07	1.86E-07	1.85E-07	non sig		4.23E-13	0	2.12E-13	non sig		1	0	0
0.31	0.46	0.39	sig		0.12	0.13	0.12	sig		0.021	0.02	0.021	non		1	1	0

													sig				
0.31	0.46	0.39	sig		0.12	0.13	0.12	sig		0.021	0.02	0.021	sig		1	1	1
0.31	0.46	0.39	non sig		0.12	0.13	0.12	non sig		0.021	0.02	0.021	non sig		1	1	1
0.38	0.47	0.42	sig		0.18	0.2	0.19	sig		0.049	0.047	0.048	sig		1	1	1
0.35	0.51	0.43	non sig		0.2	0.23	0.22	non sig		0.078	0.074	0.076	non sig		1	1	1
0.41	0.57	0.49	sig		0.39	0.54	0.47	sig		0.35	0.48	0.42	sig		1	1	1
0.41	0.57	0.49	sig		0.39	0.54	0.47	sig		0.35	0.48	0.42	sig		1	1	1
0.41	0.57	0.49	sig		0.39	0.54	0.47	sig		0.35	0.48	0.42	sig		1	1	1
0.41	0.57	0.49	sig		0.39	0.54	0.47	sig		0.35	0.48	0.42	sig		0	0	0
0.36	0.62	0.49	sig		0.36	0.6	0.48	sig		0.33	0.54	0.44	sig		1	1	1
0.36	0.62	0.49	sig		0.36	0.6	0.48	sig		0.33	0.54	0.44	sig		1	1	1
0.31	0.67	0.49	sig		0.31	0.65	0.48	sig		0.3	0.59	0.44	sig		0	0	0
0.31	0.67	0.49	sig		0.31	0.65	0.48	sig		0.3	0.59	0.44	sig		1	1	1
0.36	0.62	0.49	non sig		0.36	0.6	0.48	non sig		0.35	0.48	0.42	non sig		1	1	1
0.36	0.62	0.49	non sig		0.36	0.6	0.48	non sig		0.35	0.48	0.42	non sig		1	1	1
0.36	0.62	0.49	non sig		0.36	0.6	0.48	non sig		0.35	0.48	0.42	non sig		1	1	1
0.36	0.62	0.49	non sig		0.36	0.6	0.48	non sig		0.35	0.48	0.42	non sig		1	1	1
0.43	0.51	0.47	sig		0.4	0.48	0.44	sig		0.33	0.38	0.35	sig		1	1	1
0.19	0.28	0.24	sig		0.008	0.008	0.008	non sig		3.83E-07	3.64E-07	3.73E-07	non sig		0	1	1
0.27	0.45	0.36	sig		0.066	0.077	0.071	sig		0.00088	0.0008	0.000	non		1	1	0

										3	6	872	sig				
0.27	0.45	0.36	sig		0.066	0.077	0.071	sig		0.000883	0.00086	0.000872	non sig		1	1	0
0.25	0.34	0.3	non sig		0.03	0.032	0.031	non sig		0.000845	0.000779	0.000812	non sig		1	1	1
0.56	0.41	0.49	sig		0.5	0.35	0.43	sig		0.418	0.272	0.345	sig		1	1	1
0.029	0.033	0.031	non sig		3.93E-08	3.94E-08	3.94E-08	non sig		4.23E-13	0	2.12E-13	non sig		0	0	0
0.31	0.57	0.44	sig		0.184	0.247	0.216	sig		0.032	0.033	0.033	sig		1	1	1
0.015	0.016	0.015	sig		1.12E-08	1.08E-08	1.1E-08	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		1	0	0
0.2	0.28	0.24	sig		0.015	0.015	0.015	sig		0.000214	0.00019	0.000202	non sig		1	1	0
0.3	0.43	0.37	sig		0.09	0.1	0.1	non sig		0.0121	0.0114	0.0117	non sig		0	1	1
0.34	0.59	0.47	sig		0.28	0.39	0.33	sig		0.14	0.13	0.14	non sig		0	0	1
0.34	0.59	0.47	non sig		0.28	0.39	0.33	non sig		0.14	0.13	0.14	non sig		1	1	1
0.32	0.58	0.45	sig		0.24	0.31	0.27	sig		0.14	0.13	0.13	sig		1	1	1
0.41	0.52	0.46	sig		0.31	0.34	0.33	sig		0.19	0.18	0.18	sig		1	1	1
0.41	0.52	0.46	sig		0.31	0.34	0.33	sig		0.19	0.18	0.18	non sig		0	0	1
0.43	0.51	0.47	sig		0.33	0.34	0.34	sig		0.21	0.19	0.2	non sig		0	0	1
0.25	0.42	0.34	sig		0.046	0.052	0.049	sig		0.00025	0.000241	0.000246	non sig		1	1	0

0.29	0.53	0.41	sig		0.13	0.16	0.15	sig		0.009965	0.009965	0.009965	sig		1	1	1
0.29	0.53	0.41	sig		0.13	0.16	0.15	sig		0.009965	0.009965	0.009965	sig		1	1	1
0.25	0.43	0.34	sig		0.053	0.06	0.057	sig		0.000401	0.000388	0.000394	non sig		1	1	0
0.25	0.42	0.34	sig		0.046	0.052	0.049	sig		0.00025	0.000241	0.000246	non sig		1	1	0
0.25	0.42	0.34	sig		0.046	0.052	0.049	sig		0.00025	0.000241	0.000246	non sig		1	1	0
0.26	0.45	0.36	sig		0.063	0.073	0.068	sig		0.000754	0.000733	0.000743	non sig		1	1	0
0.37	0.59	0.48	sig		0.272892	0.422756	0.347824	sig		0.13402	0.153867	0.143943	sig		1	1	1
0.44	0.54	0.49	non sig		0.31849	0.527422	0.422956	non sig		0.230368	0.317111	0.273739	non sig		1	1	1
0.44	0.54	0.49	sig		0.31849	0.527422	0.422956	sig		0.230368	0.317111	0.273739	sig		1	1	1
0.197687	0.289425	0.243556	sig		0.008728	0.009307	0.009017	sig		6.05E-07	5.75E-07	5.9E-07	non sig		1	1	0
0.393524	0.574951	0.484238	sig		0.287356	0.455319	0.371338	sig		0.161252	0.192119	0.176686	sig		1	1	1
0.39	0.6	0.5	sig		0.38	0.57	0.47	sig		0.35	0.51	0.43	sig		1	1	1
0.33	0.58	0.46	sig		0.26	0.34	0.3	sig		0.16	0.16	0.16	sig		1	1	1
0.34	0.59	0.47	sig		0.29	0.38	0.33	sig		0.2	0.2	0.2	sig		1	1	1
0.34	0.59	0.47	sig		0.29	0.38	0.33	sig		0.2	0.2	0.2	sig		0	0	0
0.19	0.24	0.22	sig		0.00469	0.0049	0.004	sig		6.96E-	6.4E-	6.68E	non		1	1	0

					2	41	816			06	06	-06	sig				
0.01	0.02	0.01	non sig		4.45E-10	4.42E-10	4.43E-10	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		1	1	1
0.03	0.03	0.03	sig		5.93E-09	6.01E-09	5.97E-09	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		1	0	0
0.03	0.04	0.04	sig		3.71E-08	3.77E-08	3.74E-08	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		1	0	0
0.01	0.02	0.01	sig		4.45E-10	4.42E-10	4.43E-10	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		1	0	0
0.006265	0.006732	0.006499	non sig		9.64E-11	9.25E-11	9.44E-11	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		0	0	0
0.01	0.02	0.01	sig		4.45E-10	4.42E-10	4.43E-10	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		1	0	0
0.006265	0.006732	0.006499	sig		9.64E-11	9.25E-11	9.44E-11	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		1	0	0
0.01	0.02	0.01	sig		4.45E-10	4.42E-10	4.43E-10	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		1	0	0
0.08	0.1	0.1	sig		3.17E-05	3.23E-05	3.2E-05	non sig		2.89E-11	2.63E-11	2.76E-11	non sig		1	0	0
0.08	0.1	0.1	sig		3.17E-05	3.23E-05	3.2E-05	non sig		2.89E-11	2.63E-11	2.76E-11	non sig		1	0	0
0.08	0.1	0.1	sig		3.17E-05	3.23E-05	3.2E-05	non sig		2.89E-11	2.63E-11	2.76E-11	non sig		1	0	0
0.08	0.1	0.1	sig		3.17E-05	3.23E-05	3.2E-05	non sig		2.89E-11	2.63E-11	2.76E-11	non sig		1	0	0
0.02	0.02	0.02	sig		5.16E-10	4.94E-10	5.05E-10	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		1	0	0

0.02	0.03	0.03	sig		1.49E-08	1.49E-08	1.49E-08	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		1	0	0
0.01	0.01	0.01	sig		3.55E-09	3.4E-09	3.48E-09	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		1	0	0
0.02	0.03	0.03	sig		1.49E-08	1.49E-08	1.49E-08	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		1	0	0
0.006231	0.006695	0.006463	sig		9.35E-11	8.96E-11	9.15E-11	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		1	0	0
0.29	0.53	0.41	sig		0.13	0.16	0.15	sig		0.009965	0.009965	0.009965	sig		1	1	1
0.31	0.67	0.49	non sig		0.31	0.65	0.48	non sig		0.3	0.59	0.44	non sig		1	1	1
0.31	0.67	0.49	non sig		0.31	0.65	0.48	non sig		0.3	0.59	0.44	non sig		1	1	1
0.31	0.67	0.49	sig		0.31	0.65	0.48	sig		0.3	0.59	0.44	sig		0	0	0
0.3	0.54	0.42	non sig		0.15	0.18	0.16	non sig		0.14	0.14	0.14	non sig		1	1	1
0.3	0.53	0.41	non sig		0.13	0.16	0.14	non sig		0.008	0.008	0.008	non sig		1	1	1
0.3	0.54	0.42	non sig		0.15	0.18	0.16	non sig		0.14	0.14	0.14	non sig		1	1	1
0.3	0.53	0.41	non sig		0.13	0.16	0.14	non sig		0.008	0.008	0.008	non sig		1	1	1
0.3	0.54	0.42	non sig		0.13	0.16	0.14	non sig		0.008	0.008	0.008	non sig		1	1	1
0.3	0.53	0.41	non sig		0.13	0.16	0.14	non sig		0.008	0.008	0.008	non sig		1	1	1

0.3	0.54	0.42	non sig		0.13	0.16	0.14	non sig		0.008	0.008	0.008	non sig		1	1	1
0.3	0.54	0.42	non sig		0.15	0.18	0.16	non sig		0.14	0.14	0.14	non sig		1	1	1
0.3	0.54	0.42	non sig		0.15	0.18	0.16	non sig		0.14	0.14	0.14	non sig		1	1	1
0.3	0.53	0.41	non sig		0.13	0.16	0.14	non sig		0.008	0.008	0.008	non sig		1	1	1
0.3	0.54	0.42	sig		0.13	0.16	0.14	non sig		0.008	0.008	0.008	non sig		0	1	1
0.3	0.53	0.41	non sig		0.13	0.16	0.14	non sig		0.008	0.008	0.008	non sig		1	1	1
0.3	0.54	0.42	sig		0.13	0.16	0.14	non sig		0.008	0.008	0.008	non sig		0	1	1
0.3	0.53	0.41	non sig		0.13	0.16	0.14	non sig		0.008	0.008	0.008	non sig		1	1	1
0.4	0.58	0.48	sig		0.29	0.45	0.37	sig		0.16	0.19	0.18	sig		1	1	1
0.29	0.52	0.4	sig		0.12	0.15	0.13	sig		0.007	0.007	0.007	sig		1	1	1
0.34	0.59	0.46	sig		0.23	0.34	0.29	sig		0.078	0.084	0.081	sig		1	1	1
0.24	0.38	0.31	sig		0.03	0.033	0.032	sig		5.25E-05	5.04E-05	5.14E-05	non sig		1	1	0
0.26	0.44	0.35	sig		0.06	0.07	0.065	sig		0.000643	0.000625	0.000634	non sig		1	1	0
0.29	0.51	0.4	sig		0.11	0.13	0.12	sig		0.005	0.005	0.005	non sig		0	0	1
0.37	0.59	0.48	non sig		0.32	0.42	0.37	non sig		0.25	0.25	0.25	non sig		1	1	1

0.37	0.59	0.48	sig		0.32	0.42	0.37	non sig		0.25	0.25	0.25	non sig		0	1	1
0.37	0.59	0.48	non sig		0.32	0.42	0.37	non sig		0.25	0.25	0.25	non sig		1	1	1
0.2	0.26	0.23	sig		0.005217	0.005538	0.005378	non sig		7.24E-06	6.72E-06	6.98E-06	non sig		1	0	0
0.095	0.117	0.106	sig		0.000295	0.00029	0.000293	non sig		2.05E-08	1.8E-08	1.92E-08	non sig		1	0	0
0.116	0.146	0.13	sig		0.000835	0.000826	0.00083	non sig		2.46E-07	2.16E-07	2.31E-07	non sig		1	0	0
0.056	0.066	0.061	non sig		1.76E-05	1.71E-05	1.74E-05	non sig		2.3E-11	2.04E-11	2.17E-11	non sig		1	1	1
0.056	0.065	0.061	non sig		1.71E-05	1.66E-05	1.68E-05	non sig		2.12E-11	1.89E-11	2.01E-11	non sig		1	1	1
0.18	0.25	0.22	sig		0.0091	0.009267	0.009184	non sig		7E-05	6.21E-05	6.6E-05	non sig		1	0	0
0.24	0.37	0.3	non sig		0.043	0.046	0.045	non sig		0.0026	0.0024	0.0025	non sig		1	1	1
0.24	0.38	0.31	sig		0.045	0.048	0.046	non sig		0.0029	0.0026	0.0027	non sig		0	1	1
0.2	0.29	0.25	sig		0.017	0.018	0.018	non sig		0.000319	0.000285	0.000302	non sig		0	1	1
0.2	0.3	0.25	non sig		0.018	0.019	0.018	non sig		0.000346	0.000308	0.000327	non sig		1	1	1
0.39	0.58	0.48	sig		0.36	0.47	0.41	sig		0.27	0.24	0.26	sig		1	1	1
0.4	0.58	0.48	sig		0.29	0.45	0.37	sig		0.16	0.19	0.18	sig		1	1	1
0.44	0.54	0.49	sig		0.31849	0.5274	0.422	sig		0.23036	0.3171	0.273	sig		1	1	1

						22	956			8	11	739					
0.44	0.54	0.49	sig		0.31849	0.527422	0.422956	sig		0.230368	0.317111	0.273739	sig		1	1	1
0.42	0.55	0.49	sig		0.3	0.5	0.4	sig		0.19	0.24	0.22	non sig		0	0	1
0.42	0.55	0.49	sig		0.3	0.5	0.4	sig		0.19	0.24	0.22	sig		1	1	1
0.39	0.57	0.48	sig		0.32	0.56	0.44	non sig		0.26	0.43	0.34	non sig		0	1	1
0.32	0.58	0.45	sig		0.24	0.31	0.27	sig		0.13	0.13	0.13	sig		1	1	1
0.32	0.58	0.45	sig		0.24	0.31	0.27	sig		0.13	0.13	0.13	sig		1	1	1
0.34	0.59	0.46	sig		0.23	0.34	0.29	sig		0.078	0.084	0.081	sig		1	1	1
0.29	0.37	0.33	sig		0.04	0.04	0.04	sig		0.001	0.001	0.001	non sig		1	1	0
0.32	0.58	0.45	sig		0.19	0.21	0.23	sig		0.039	0.04	0.039	sig		1	1	1
0.42	0.55	0.49	sig		0.3	0.5	0.4	sig		0.19	0.24	0.22	sig		1	1	1
0.24	0.38	0.31	sig		0.03	0.033	0.032	sig		5.25E-05	5.04E-05	5.14E-05	non sig		1	1	0
0.24	0.38	0.31	sig		0.03	0.033	0.032	sig		5.25E-05	5.04E-05	5.14E-05	non sig		1	1	0
0.29	0.53	0.41	sig		0.13	0.16	0.15	sig		0.009965	0.009965	0.009965	sig		1	1	1
0.29	0.53	0.41	sig		0.13	0.16	0.15	sig		0.009965	0.009965	0.009965	non sig		1	1	0
0.36	0.6	0.47	sig		0.26	0.39	0.33	sig		0.11	0.12	0.12	sig		1	1	1
0.4	0.58	0.48	sig		0.29	0.45	0.37	sig		0.16	0.19	0.18	sig		0	0	0
0.3	0.55	0.43	sig		0.16	0.21	0.18	sig		0.19	0.2	0.2	sig		1	1	1
0.25	0.41	0.33	sig		0.044	0.05	0.047	sig		0.00021	0.0002	0.000	non		1	1	0

										4	06	21	sig				
0.25	0.42	0.34	non sig		0.046	0.052	0.049	non sig		0.00025	0.000241	0.000246	non sig		1	1	1
0.32	0.46	0.39	non sig		0.12	0.14	0.13	non sig		0.23	0.22	0.22	non sig		1	1	1
0.28	0.5	0.39	sig		0.1	0.12	0.11	sig		0.0037	0.0037	0.0037	non sig		1	1	0
0.28	0.5	0.39	sig		0.1	0.12	0.11	sig		0.0037	0.0037	0.0037	non sig		1	1	0
0.21	0.31	0.26	sig		0.11	0.12	0.12	sig		1.51E-06	1.44E-06	1.48E-06	non sig		1	1	0
0.2	0.29	0.25	sig		0.009	0.01	0.009	non sig		7.05E-07	6.7E-07	6.88E-07	non sig		0	1	1
0.21	0.31	0.26	sig		0.009	0.01	0.009	sig		7.05E-07	6.7E-07	6.88E-07	non sig		1	1	0
0.37	0.48	0.42	sig		0.18	0.2	0.19	sig		0.05	0.48	0.49	sig		1	1	1
0.37	0.48	0.42	non sig		0.18	0.2	0.19	non sig		0.05	0.48	0.49	non sig		1	1	1
0.23	0.31	0.27	sig		0.018	0.019	0.019	non sig		0.000245	0.000224	0.000235	non sig		0	1	1
0.19	0.27	0.23	sig		0.012	0.012	0.012	non sig		0.000122	0.000109	0.000115	non sig		1	0	0
0.23	0.31	0.27	non sig		0.018	0.019	0.019	non sig		0.000245	0.000224	0.000235	non sig		1	1	1
0.26	0.34	0.3	sig		0.027	0.029	0.028	non sig		0.000501	0.000467	0.000484	non sig		0	1	1
0.23	0.31	0.27	sig		0.018	0.019	0.019	non		0.00024	0.0002	0.000	non		1	0	0

								sig		5	24	235	sig				
0.23	0.31	0.27	non sig		0.018	0.019	0.019	non sig		0.000245	0.000224	0.000235	non sig		1	1	1
0.19	0.27	0.23	sig		0.012	0.012	0.012	sig		0.000122	0.000109	0.000115	non sig		1	1	0
0.23	0.31	0.27	non sig		0.018	0.019	0.019	non sig		0.000245	0.000224	0.000235	non sig		1	1	1
0.26	0.34	0.3	sig		0.027	0.029	0.028	sig		0.000501	0.000467	0.000484	non sig		1	1	0
0.3	0.5	0.4	sig		0.15	0.2	0.17	sig		0.016	0.017	0.016	non sig		1	1	0
0.3	0.5	0.42	sig		0.15	0.18	0.16	sig		0.014	0.014	0.014	non sig		1	1	0
0.29	0.51	0.4	sig		0.11	0.14	0.13	sig		0.006	0.006	0.006	non sig		0	0	1
0.02	0.02	0.02	non sig		3.46E-09	3.46E-09	3.46E-09	non sig		4.23E-13	0	2.12E-13	non sig		1	1	1
0.28	0.52	0.4	sig		0.13	0.17	0.15	sig		0.011	0.011	0.011	sig		1	1	1
0.025	0.028	0.027	non sig		1.56E-08	1.56E-08	1.56E-08	non sig		4.23E-13	0	2.12E-13	non sig		1	1	1
0.025	0.028	0.027	non sig		1.56E-08	1.56E-08	1.56E-08	non sig		4.23E-13	0	2.12E-13	non sig		1	1	1
0.37	0.59	0.48	sig		0.32	0.42	0.37	sig		0.25	0.25	0.25	sig		1	1	1
0.314	0.594	0.454	sig		0.165	0.2	0.182	sig		0.05	0.054	0.055	sig		1	1	1
0.29	0.54	0.41	non sig		0.077	0.085	0.081	non sig		0.01	0.01	0.01	non sig		1	1	1
0.355	0.546	0.45	sig		0.153	0.175	0.163	sig		0.04	0.038	0.04	sig		1	1	1

0.376	0.504	0.44	sig		0.112	0.124	0.118	non sig		0.016	0.015	0.015	non sig		0	1	1
0.376	0.504	0.44	sig		0.112	0.124	0.118	non sig		0.016	0.015	0.015	non sig		0	1	1
0.376	0.504	0.44	sig		0.112	0.124	0.118	non sig		0.016	0.015	0.015	non sig		0	1	1
0.21	0.31	0.26	sig		0.011	0.012	0.012	sig		1.51E-06	1.44E-06	1.48E-06	non sig		1	1	0
0.3	0.55	0.43	sig		0.16	0.21	0.18	non sig		0.0194	0.0197	0.0196	non sig		0	1	1
0.31	0.56	0.43	sig		0.2	0.25	0.23	sig		0.09	0.088	0.089	non sig		0	0	1
0.31	0.56	0.43	non sig		0.2	0.25	0.23	non sig		0.09	0.088	0.089	non sig		1	1	1
0.328	0.586	0.457	sig		0.256	0.346	0.301	sig		0.107	0.095	0.101	sig		1	1	1
0.401	0.544	0.473	sig		0.251	0.28	0.27	sig		0.117	0.11	0.114	sig		1	1	1
0.401	0.544	0.473	sig		0.251	0.28	0.27	sig		0.117	0.11	0.114	sig		1	1	1
0.401	0.544	0.473	non sig		0.251	0.28	0.27	non sig		0.117	0.11	0.114	non sig		1	1	1
0.401	0.544	0.473	sig		0.251	0.28	0.27	sig		0.117	0.11	0.114	sig		0	0	0
0.37	0.61	0.49	non sig		0.323	0.421	0.372	non sig		0.254	0.252	0.253	non sig		1	1	1
0.37	0.61	0.49	sig		0.323	0.421	0.372	sig		0.254	0.252	0.253	sig		0	0	0
0.37	0.61	0.49	sig		0.323	0.421	0.372	sig		0.254	0.252	0.253	sig		0	0	0
0.33	0.58	0.46	sig		0.26	0.34	0.3	non sig		0.162	0.161	0.162	non sig		0	1	1
0.33	0.58	0.46	sig		0.26	0.34	0.3	sig		0.162	0.161	0.162	sig		1	1	1

0.33	0.58	0.46	sig		0.26	0.34	0.3	sig		0.162	0.161	0.162	sig		1	1	1
0.33	0.58	0.46	sig		0.26	0.34	0.3	sig		0.162	0.161	0.162	sig		1	1	1
0.413	0.54	0.48	sig		0.29	0.32	0.3	sig		0.162	0.151	0.157	sig		1	1	1
3.18E-05	3.3E-05	3.24E-05	sig		4.23E-13	-3.9E-13	1.74E-14	sig		4.23E-13	-3.9E-13	1.74E-14	sig		1	1	1
0.339	0.636	0.488	sig		0.318	0.542	0.43	sig		0.249	0.329	0.289	sig		1	1	1
0.402	0.544	0.479	sig		0.251	0.28	0.27	sig		0.117	0.111	0.114	non sig		0	0	1
0.402	0.544	0.479	sig		0.251	0.28	0.27	sig		0.117	0.111	0.114	sig		1	1	1
0.309	0.462	0.386	non sig		0.034	0.037	0.036	non sig		0.001	0.001	0.001	non sig		1	1	1
0.479	0.501	0.49	sig		0.411	0.383	0.397	sig		0.322	0.26	0.29	sig		1	1	1
0.452	0.503	0.478	sig		0.288	0.29	0.29	sig		0.135	0.121	0.128	non sig		0	0	1
0.306	0.471	0.389	sig		0.064	0.078	0.071	sig		0.003153	0.003512	0.003333	sig		1	1	1
0.284	0.414	0.345	sig		0.013	0.014	0.014	non sig		0.000113	0.000103	0.000108	non sig		0	1	1
0.366	0.558	0.462	non sig		0.2	0.23	0.21	non sig		0.071	0.068	0.07	non sig		1	1	1
0.267	0.463	0.366	sig		0.073	0.084	0.079	non sig		0.0012	0.0012	0.0012	non sig		0	1	1
0.433	0.409	0.42	sig		0.338	0.286	0.312	sig		0.211	0.141	0.176	sig		1	1	1
0.421	0.402	0.412	sig		0.313	0.27	0.29	sig		0.175	0.121	0.148	sig		1	1	1
0.35	0.62	0.48	sig		0.29	0.38	0.33	non sig		0.2	0.2	0.2	non sig		0	1	1
0.45	0.52	0.49	non		0.358	0.361	0.36	non		0.25	0.21	0.23	non		1	1	1

			sig					sig					sig				
0.09	0.11	0.1	sig		0.000188	0.000193	0.00019	sig		4.23E-13	4.21E-13	4.22E-13	non sig		1	1	0
0.33	0.64	0.48	sig		0.3	0.52	0.41	sig		0.22	0.28	0，25	sig		1	1	1
0.402	0.544	0.479	sig		0.251	0.28	0.27	sig		0.117	0.111	0.114	sig		0	0	0
0.3	0.53	0.42	sig		0.17	0.21	0.19	sig		0.062	0.06	0.061	sig		1	1	1
0.37	0.61	0.49	non sig		0.323	0.421	0.372	non sig		0.254	0.252	0.253	non sig		1	1	1
0.293	0.402	0.348	sig		0.009724	0.010323	0.010024	non sig		4.21E-05	3.89E-05	4.05E-05	non sig		1	0	0
0.307	0.56	0.43	non sig		0.168	0.22	0.193	non sig		0.023	0.023	0.023	non sig		1	1	1
0.318	0.602	0.46	non sig		0.185	0.23	0.21	non sig		0.075	0.072	0.073	non sig		1	1	1
0.318	0.602	0.46	sig		0.185	0.23	0.21	sig		0.075	0.072	0.073	non sig		0	0	1
0.3	0.53	0.42	sig		0.17	0.21	0.19	sig		0.062	0.06	0.061	sig		1	1	1
0.3	0.53	0.42	sig		0.17	0.21	0.19	sig		0.062	0.06	0.061	sig		1	1	1
0.354	0.544	0.449	non sig		0.148	0.16	0.158	non sig		0.037	0.035	0.036	non sig		1	1	1
0.354	0.544	0.449	non sig		0.148	0.16	0.158	non sig					non sig		1	1	1
0.321	0.638	0.479	sig		0.286	0.492	0.388	sig		0.18	0.23	0.21	sig		0	0	0
0.354	0.353	0.353	sig		0.175	0.174	0.174	sig		0.031	0.03	0.031	sig		1	1	1
0.407	0.561	0.484	sig		0.325	0.369	0.347	sig		0.223	0.207	0.215	sig		0	0	0
0.407	0.561	0.484	sig		0.325	0.369	0.347	sig		0.223	0.207	0.215	sig		0	0	0
0.42	0.55	0.49	sig		0.39	0.44	0.42	sig		0.35	0.31	0.33	sig		1	1	1

0.288	0.551	0.419	sig		0.117	0.15	0.134	non sig		0.02	0.022	0.021	non sig		0	1	1
0.29	0.52	0.4	sig		0.12	0.15	0.13	sig		0.007	0.007	0.007	non sig		0	0	1
0.26	0.45	0.36	sig		0.063	0.073	0.068	non sig		0.000754	0.000733	0.000743	non sig		0	1	1
0.26	0.45	0.36	sig		0.063	0.073	0.068	non sig		0.000754	0.000733	0.000743	non sig		0	1	1
0.294	0.531	0.413	non sig		0.132	0.165	0.149	non sig		0.01	0.01	0.01	non sig		1	1	1
0.416	0.482	0.45	sig		0.124	0.13	0.127	non sig		0.015	0.014	0.014	non sig		0	1	1
0.416	0.482	0.45	sig		0.124	0.13	0.127	sig		0.015	0.014	0.014	non sig		1	1	0
0.413	0.544	0.479	non sig		0.289	0.319	0.304	non sig		0.162	0.15	0.157	non sig		1	1	1
0.28	0.379	0.308	non sig		0.096	0.114	0.105	non sig		0.0032	0.0031	0.0032	non sig		1	1	1
0.12	0.153	0.137	sig		0.000348	0.000358	0.000353	non sig		3.9E-12	3.75E-12	3.82E-12	non sig		1	0	0
0.301	0.548	0.425	sig		0.152	0.195	0.174	sig		0.0164	0.0166	0.0165	non sig		1	1	0
0.301	0.548	0.425	sig		0.152	0.195	0.174	sig		0.0164	0.0166	0.0165	non sig		1	1	0
0.271	0.347	0.31	non sig		0.001584	0.001674	0.001629	non sig		2.92E-07	2.7E-07	2.81E-07	non sig		1	1	1
0.271	0.347	0.31	sig		0.00158	0.0016	0.001	non		2.92E-	2.7E-	2.81E	non		1	0	0

					4	74	629	sig		07	07	-07	sig				
0.271	0.347	0.31	sig		0.001584	0.001674	0.001629	non sig		2.92E-07	2.7E-07	2.81E-07	non sig		1	0	0
0.37	0.61	0.49	non sig		0.323	0.421	0.372	non sig		0.254	0.252	0.253	non sig		1	1	1
0.39	0.54	0.47	sig		0.31	0.36	0.33	sig		0.2	0.19	0.2	sig		1	1	1
0.37	0.61	0.49	non sig		0.323	0.421	0.372	non sig		0.254	0.252	0.253	non sig		1	1	1
0.37	0.61	0.49	sig		0.323	0.421	0.372	sig		0.254	0.252	0.253	sig		0	0	0
0.352	0.542	0.447	sig		0.143	0.162	0.153	non sig		0.034	0.032	0.033	non sig		0	1	1
0.3	0.53	0.42	sig		0.17	0.21	0.19	sig		0.062	0.06	0.061	sig		1	1	1
0.3	0.57	0.44	sig		0.116	0.134	0.125	sig		0.026	0.024	0.025	sig		1	1	1
0.054	0.064	0.059	non sig		3.75E-12	3.79E-12	3.77E-12	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		1	1	1
0.054	0.064	0.059	non sig		3.75E-12	3.79E-12	3.77E-12	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		1	1	1
0.054	0.064	0.059	sig		3.75E-12	3.79E-12	3.77E-12	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		1	0	0
0.3	0.54	0.42	sig		0.145	0.184	0.165	sig		0.0134	0.014	0.014	sig		1	1	1
0.325	0.585	0.455	sig		0.213	0.3	0.256	sig		0.054	0.057	0.056	sig		1	1	1
0.325	0.585	0.455	sig		0.213	0.3	0.256	non sig		0.054	0.057	0.056	non sig		0	1	1
0.325	0.585	0.455	sig		0.213	0.3	0.256	sig		0.054	0.057	0.056	sig		1	1	1
0.206	0.302	0.254	sig		0.0193	0.02	0.0197	non sig		2.01E-05	1.65E-05	1.83E-05	non sig		1	0	0
0.308	0.636	0.472	sig		0.236	0.384	0.31	non		0.132	0.173	0.152	non		0	1	1

								sig					sig				
0.201	0.294	0.249	sig		0.001158	0.001149	0.001153	non sig		5.35E-07	4.71E-07	5.03E-07	non sig		0	1	1
0.329	0.586	0.457	non sig		0.256	0.346	0.3	non sig		0.107	0.095	0.101	non sig		1	1	1
0.284	0.504	0.394	sig		0.104	0.126	0.116	sig		0.0044	0.0043	0.0044	non sig		1	1	0
0.32	0.68	0.5	non sig		0.31	0.65	0.48	non sig		0.3	0.6	0.44	non sig		1	1	1
0.374	0.564	0.469	sig		0.226	0.263	0.245	sig		0.1	0.095	0.098	sig		1	1	1
0.144	0.193	0.169	non sig		0.000333	0.00035	0.000341	non sig		4.24E-09	4.33E-09	4.28E-09	non sig		1	1	1
0.168	0.234	0.201	non sig		0.001101	0.001169	0.001135	non sig		1.03E-07	1.05E-07	1.04E-07	non sig		1	1	1
0.142	0.189	0.166	sig		0.002345	0.002469	0.002407	sig		5.07E-09	4.87E-09	4.97E-09	non sig		1	1	0
0.331	0.589	0.46	sig		0.223	0.319	0.271	sig		0.065	0.069	0.067	sig		1	1	1
0.415	0.557	0.486	sig		0.341	0.382	0.362	sig		0.247	0.226	0.236	sig		1	1	1
0.243	0.394	0.318	sig		0.036	0.04	0.038	sig		9.78E-05	9.41E-05	9.59E-05	non sig		1	1	0
0.265	0.454	0.36	sig		0.066	0.077	0.071	sig		0.000883	0.00086	0.000872	non sig		1	1	0
0.265	0.454	0.36	sig		0.066	0.077	0.071	sig		0.000883	0.00086	0.000872	non sig		1	1	0
0.265	0.454	0.36	sig		0.066	0.077	0.071	sig		0.000883	0.00086	0.000872	non sig		1	1	0
0.265	0.454	0.36	sig		0.066	0.077	0.071	sig		0.00088	0.0008	0.000	non		1	1	0

										3	6	872	sig				
0.0124	0.0137	0.0131	sig		1.48E-10	1.48E-10	1.48E-10	non sig		4.23E-13	0	2.12E-13	non sig		1	0	0
0.281	0.369	0.325	non sig		0.003562	0.003769	0.003665	non sig		2.78E-06	2.57E-06	2.68E-06	non sig		1	1	1
0.281	0.369	0.325	sig		0.003562	0.003769	0.003665	non sig		2.78E-06	2.57E-06	2.68E-06	non sig		0	1	1
0.281	0.369	0.325	sig		0.003562	0.003769	0.003665	non sig		2.78E-06	2.57E-06	2.68E-06	non sig		0	1	1
0.217	0.33	0.274	non sig		0.002552	0.002551	0.002551	non sig		3.49E-06	3.08E-06	3.29E-06	non sig		1	1	1
0.257	0.364	0.31	non sig		0.004193	0.004351	0.004272	non sig		7.13E-06	6.46E-06	6.79E-06	non sig		1	1	1
0.257	0.364	0.31	sig		0.004193	0.004351	0.004272	non sig		7.13E-06	6.46E-06	6.79E-06	non sig		1	0	0
0.269	0.463	0.366	sig		0.073	0.084	0.0079	sig		0.0012	0.0012	0.0012	sig		1	1	1
0.32	0.577	0.449	sig		0.235	0.311	0.273	sig		0.081	0.071	0.076	sig		1	1	1
0.358	0.55	0.454	sig		0.164	0.188	0.176	non sig		0.043	0.047	0.045	non sig		0	1	1
0.42	0.56	0.49	sig		0.392	0.444	0.418	sig		0.347	0.31	0.328	sig		0	0	0
0.388	0.592	0.49	sig		0.35	0.44	0.394	sig		0.292	0.282	0.287	sig		1	1	1
0.297	0.554	0.425	sig		0.097	0.109	0.103	sig		0.0167	0.0153	0.016	sig		1	1	1
0.269	0.463	0.366	non sig		0.073	0.084	0.0079	non sig		0.0012	0.0012	0.0012	non sig		1	1	1
0.33	0.47	0.4	sig		0.043	0.047	0.045	non sig		0.0017	0.0016	0.0016	non sig		0	1	1

0.205	0.309	0.257	sig		0.005498	0.005964	0.005731	non sig		7.21E-06	7.45E-06	7.33E-06	non sig		1	0	0
0.29	0.53	0.41	non sig		0.067	0.073	0.07	non sig		0.0071	0.0065	0.0068	non sig		1	1	1
0.42	0.55	0.49	sig		0.39	0.44	0.42	sig		0.35	0.31	0.33	sig		1	1	1
0.32	0.57	0.44	sig		0.23	0.29	0.26	sig		0.12	0.12	0.12	sig		0	0	0
0.41	0.47	0.44	sig		3.08E-06	2.98E-06	3.03E-06	non sig		4.23E-13	4.64E-12	2.53E-12	non sig		1	0	0
0.32	0.57	0.44	non sig		0.23	0.29	0.26	non sig		0.12	0.12	0.12	non sig		1	1	1
0.32	0.57	0.44	non sig		0.23	0.29	0.26	non sig		0.12	0.12	0.12	non sig		1	1	1
0.42	0.5	0.46	sig		0.32	0.34	0.33	sig		0.19	0.17	0.18	sig		1	1	1
0.49	0.48	0.49	sig		0.46	0.4	0.43	sig		0.412	0.3	0.36	sig		0	0	0
0.42	0.55	0.49	sig		0.39	0.44	0.42	sig		0.35	0.31	0.33	sig		0	0	0
0.056	0.065	0.061	sig		2.61E-06	2.63E-06	2.62E-06	non sig		4.23E-13	0	2.12E-13	non sig		1	0	0
0.23	0.36	0.29	sig		0.036	0.038	0.037	non sig		0.0017	0.0016	0.0017	non sig		0	1	1
0.23	0.36	0.29	sig		0.036	0.038	0.037	sig		0.0017	0.0016	0.0017	non sig		1	1	0
0.25	0.41	0.33	sig		0.064	0.07	0.068	sig		0.0066	0.006	0.006	non sig		1	1	0
0.25	0.41	0.33	non sig		0.064	0.07	0.068	non sig		0.0066	0.006	0.006	non sig		1	1	1
0.38	0.54	0.46	sig		0.27	0.32	0.3	sig		0.154	0.146	0.15	sig		0	0	0
0.21	0.31	0.26	non		0.02	0.021	0.021	non		0.00047	0.0004	0.000	non		1	1	1

			sig					sig		7	26	452	sig				
0.24	0.33	0.29	non sig		0.027	0.028	0.028	non sig		0.000619	0.00057	0.000595	non sig		1	1	1
0.276	0.498	0.387	sig		0.116	0.144	0.13	sig		0.0065	0.0066	0.0065	non sig		0	0	1
0.301	0.548	0.424	sig		0.152	0.2	0.17	sig		0.0164	0.0165	0.0164	sig		1	1	1
0.36	0.53	0.44	non sig		0.235	0.27	0.25	non sig		0.109	0.104	0.106	non sig		1	1	1
0.36	0.53	0.44	sig		0.235	0.27	0.25	sig		0.109	0.104	0.106	sig		1	1	1
0.36	0.53	0.44	sig		0.235	0.27	0.25	sig		0.109	0.104	0.106	sig		1	1	1
0.36	0.53	0.44	non sig		0.235	0.27	0.25	non sig		0.109	0.104	0.106	non sig		1	1	1
0.25	0.42	0.33	sig		0.0613	0.0712	0.0662	sig		0.000686	0.000678	0.000682	non sig		1	1	0
0.25	0.42	0.33	sig		0.0613	0.0712	0.0662	sig		0.000686	0.000678	0.000682	non sig		1	1	0
0.132	0.172	0.152	sig		0.000635	0.000656	0.000645	sig		3.74E-11	3.54E-11	3.64E-11	non sig		1	1	0
0.25	0.35	0.3	non sig		0.031	0.034	0.032	non sig		0.000913	0.000842	0.000877	non sig		1	1	1
0.33	0.45	0.39	sig		0.12	0.13	0.12	sig		0.02	0.019	0.02	sig		1	1	1
0.31	0.56	0.43	sig		0.2	0.25	0.23	sig		0.09	0.088	0.089	sig		1	1	1
0.35	0.59	0.47	sig		0.3	0.4	0.35	sig		0.225	0.225	0.225	sig		0	0	0
3.18E-05	3.3E-05	3.24E-05	sig		4.23E-13	-3.9E-13	1.74E-14	sig		4.23E-13	-3.9E-13	1.74E-14	sig		1	1	1
0.46	0.48	0.47	sig		0.34	0.33	0.34	sig		0.2	0.17	0.19	sig		1	1	1

0.46	0.48	0.47	sig		0.34	0.33	0.34	sig		0.2	0.17	0.19	sig		0	0	0
0.24	0.3	0.25	non sig		0.019	0.019	0.019	non sig		0.000375	0.000334	0.000355	non sig		1	1	1
0.24	0.3	0.25	non sig		0.019	0.019	0.019	non sig		0.000375	0.000334	0.000355	non sig		1	1	1
0.24	0.32	0.27	sig		0.025	0.026	0.025	non sig		0.000714	0.00064	0.000677	non sig		0	1	1
0.3	0.53	0.42	non sig		0.178	0.219	0.2	non sig		0.068	0.065	0.067	non sig		1	1	1
0.21	0.3	0.26	sig		0.178	0.219	0.2	sig		0.00044	0.000393	0.000417	non sig		0	0	1
0.21	0.3	0.26	non sig		0.178	0.219	0.2	non sig		0.00044	0.000393	0.000417	non sig		1	1	1
0.21	0.3	0.26	non sig		0.178	0.219	0.2	non sig		0.00044	0.000393	0.000417	non sig		1	1	1
0.21	0.3	0.26	sig		0.178	0.219	0.2	sig		0.00044	0.000393	0.000417	non sig		1	1	0
0.21	0.3	0.26	sig		0.178	0.219	0.2	sig		0.00044	0.000393	0.000417	non sig		1	1	0
0.33	0.58	0.46	sig		0.26	0.34	0.3	sig		0.162	0.161	0.162	sig		1	1	1
0.18	0.25	0.21	non sig		0.008222	0.008357	0.008289	non sig		5.51E-05	4.89E-05	5.2E-05	non sig		1	1	1
0.18	0.25	0.21	non sig		0.008222	0.008357	0.008289	non sig		5.51E-05	4.89E-05	5.2E-05	non sig		1	1	1
0.022	0.025	0.023	sig		2.37E-08	2.33E-08	2.35E-08	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		1	0	0
0.022	0.025	0.023	sig		2.37E-	2.33E-	2.35E	non		4.23E-	4.63E-	2.53E	non		1	0	0

					08	08	-08	sig		13	12	-12	sig				
0.022	0.025	0.023	sig		2.37E-08	2.33E-08	2.35E-08	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		1	0	0
0.015	0.016	0.015	non sig		1.06E-08	1.01E-08	1.03E-08	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		1	1	1
0.015	0.016	0.015	sig		1.06E-08	1.01E-08	1.03E-08	non sig		4.23E-13	4.63E-12	2.53E-12	non sig		1	0	0
0.317	0.576	0.446	sig		0.193	0.263	0.228	sig		0.038	0.04	0.039	sig		1	1	1
0.29	0.42	0.35	non sig		0.076	0.083	0.079	non sig		0.0076	0.007	0.007	non sig		1	1	1
0.29	0.5	0.39	non sig		0.13	0.15	0.14	non sig		0.033	0.031	0.032	non sig		1	1	1
0.29	0.5	0.39	non sig		0.13	0.15	0.14	non sig		0.033	0.031	0.032	non sig		1	1	1
0.38	0.58	0.48	sig		0.35	0.44	0.39	sig		0.29	0.28	0.29	sig		1	1	1
0.4	0.52	0.46	sig		0.29	0.32	0.3	sig		0.161	0.151	0.157	sig		1	1	1
0.33	0.58	0.46	sig		0.26	0.34	0.3	sig		0.162	0.161	0.162	sig		1	1	1
0.33	0.58	0.46	sig		0.26	0.34	0.3	sig		0.162	0.161	0.162	sig		1	1	1
0.33	0.58	0.46	non sig		0.26	0.34	0.3	non sig		0.162	0.161	0.162	non sig		1	1	1
0.33	0.58	0.46	non sig		0.26	0.34	0.3	non sig		0.162	0.161	0.162	non sig		1	1	1
0.43	0.5	0.47	sig		0.32	0.33	0.33	sig		0.19	0.17	0.18	sig		1	1	1
0.43	0.5	0.47	sig		0.32	0.33	0.33	sig		0.19	0.17	0.18	sig		1	1	1
0.43	0.5	0.47	sig		0.32	0.33	0.33	sig		0.19	0.17	0.18	non sig		0	0	1
0.43	0.5	0.47	sig		0.32	0.33	0.33	sig		0.19	0.17	0.18	sig		1	1	1

0.43	0.5	0.47	non sig		0.32	0.33	0.33	non sig		0.19	0.17	0.18	non sig		1	1	1
0.43	0.5	0.47	sig		0.32	0.33	0.33	sig		0.19	0.17	0.18	sig		1	1	1
0.43	0.5	0.47	sig		0.32	0.33	0.33	sig		0.19	0.17	0.18	sig		1	1	1
0.31	0.39	0.35	sig		0.32	0.33	0.33	sig		0.19	0.17	0.18	sig		1	1	1
0.28	0.37	0.32	sig		0.043	0.047	0.045	sig		0.0028	0.0026	0.0027	sig		1	1	1
0.37	0.42	0.4	sig		0.106	0.117	0.109	sig		0.0017	0.0016	0.0016	sig		1	1	1
0.42	0.47	0.45	sig		0.26	0.27	0.26	sig		0.0089	0.0084	0.0086	sig		1	1	1
0.42	0.47	0.45	sig		0.26	0.27	0.26	sig		0.105	0.096	0.101	sig		1	1	1
0.295	0.524	0.41	sig		0.158	0.191	0.174	sig		0.216	0.184	0.02	sig		0	0	0
0.346	0.595	0.47	sig		0.294	0.406	0.35	sig		0.166	0.15	0.159	sig		0	0	0
0.295	0.524	0.41	non sig		0.158	0.191	0.174	non sig		0.216	0.184	0.02	non sig		1	1	1
0.346	0.595	0.47	sig		0.294	0.406	0.35	sig		0.166	0.15	0.159	non sig		0	0	1
0.295	0.524	0.41	non sig		0.158	0.191	0.174	non sig		0.216	0.184	0.02	non sig		1	1	1
0.346	0.595	0.47	sig		0.294	0.406	0.35	sig		0.166	0.15	0.159	sig		0	0	0
0.292	0.526	0.409	non sig		0.126	0.156	0.141	non sig		0.0085	0.0084	0.0084	non sig		1	1	1
0.292	0.526	0.409	non sig		0.126	0.156	0.141	non sig		0.0085	0.0084	0.0084	non sig		1	1	1
0.292	0.526	0.409	sig		0.126	0.156	0.141	sig		0.0085	0.0084	0.0084	sig		1	1	1

0.33	0.59	0.46	non sig		0.224	0.319	0.271	non sig		0.065	0.069	0.067	non sig		1	1	1
0.33	0.59	0.46	sig		0.224	0.319	0.271	non sig		0.065	0.069	0.067	non sig		0	1	1
0.33	0.59	0.46	non sig		0.224	0.319	0.271	non sig		0.065	0.069	0.067	non sig		1	1	1
0.34	0.44	0.39	sig		0.117	0.127	0.122	sig		0.0161	0.0153	0.0157	non sig		1	1	0
0.35	0.44	0.39	non sig		0.13	0.14	0.14	non sig		0.0214	0.02	0.021	non sig		1	1	1
0.301	0.54	0.42	sig		0.177	0.219	0.198	non sig		0.032	0.027	0.03	non sig		0	1	1
0.241	0.382	0.312	non sig		0.048	0.052	0.05	non sig		0.000429	0.000357	1	non sig		1	1	1
0.354	0.594	0.475	sig		0.311	0.427	0.369	sig		0.194	0.176	0.185	sig		0	0	0
0.354	0.594	0.475	sig		0.311	0.427	0.369	sig		0.194	0.176	0.185	non sig		0	0	1
0.354	0.594	0.475	sig		0.311	0.427	0.369	sig		0.194	0.176	0.185	sig		0	0	0
0.276	0.483	0.38	sig		0.087	0.102	0.095	non sig		0.0023	0.0023	0.0023	non sig		0	1	1
0.44	0.54	0.49	sig		0.32	0.53	0.42	sig		0.23	0.32	0.27	sig		0	0	0
0.44	0.54	0.49	sig		0.32	0.53	0.42	sig		0.23	0.32	0.27	non sig		0	0	1
0.252	0.425	0.339	sig		0.065	0.076	0.07	non sig		0.000835	0.000826	0.00083	non sig		0	1	1
0.338	0.592	0.465	non sig		0.234	0.342	0.288	non sig		0.076	0.084	0.081	non sig		1	1	1

0.223	0.344	0.283	non sig		0.019	0.021	0.02	non sig		1.12E-05	1.07E-05	1.09E-05	non sig		1	1	1
0.245	0.398	0.321	non sig		0.037	0.042	0.039	non sig		0.000114	0.00011	0.000112	non sig		1	1	1
0.249	0.41	0.33	non sig		0.0425	0.0477	0.0451	non sig		0.000183	0.000176	0.000179	non sig		1	1	1
0.245	0.411	0.328	non sig		0.026	0.03	0.028	non sig		0.000417	0.000439	0.000428	non sig		1	1	1
0.262	0.46	0.36	non sig		0.047	0.055	0.051	non sig		0.0019	0.002029	0.001964	non sig		1	1	1
0.5	0.48	0.49	sig		0.48	0.41	0.45	sig		0.452	0.316	0.384	sig		1	1	1
0.5	0.48	0.49	sig		0.48	0.41	0.45	non sig		0.452	0.316	0.384	non sig		0	1	1
0.5	0.48	0.49	non sig		0.48	0.41	0.45	non sig		0.452	0.316	0.384	non sig		1	1	1
0.29	0.52	0.41	sig		0.15	0.18	0.17	sig		0.047	0.045	0.046	sig		1	1	1
0.42	0.53	0.48	sig		0.36	0.39	0.37	sig		0.27	0.25	0.26	sig		1	1	1
0.34	0.59	0.47	sig		0.29	0.38	0.33	sig		0.2	0.2	0.2	sig		1	1	1
0.448	0.439	0.444	sig		0.373	0.352	0.362	sig		0.261	0.227	0.244	sig		1	1	1
0.448	0.439	0.444	sig		0.373	0.352	0.362	sig		0.261	0.227	0.244	sig		1	1	1
0.448	0.439	0.444	sig		0.373	0.352	0.362	sig		0.261	0.227	0.244	sig		1	1	1
0.448	0.439	0.444	sig		0.373	0.352	0.362	sig		0.261	0.227	0.244	sig		1	1	1
0.448	0.439	0.444	sig		0.373	0.352	0.362	sig		0.261	0.227	0.244	sig		1	1	1
0.35	0.52	0.43	non sig		0.21	0.24	0.23	non sig		0.084	0.081	0.082	non sig		1	1	1
0.35	0.52	0.43	non sig		0.21	0.24	0.23	non sig		0.084	0.081	0.082	non sig		1	1	1

0.35	0.52	0.43	non sig		0.21	0.24	0.23	non sig		0.084	0.081	0.082	non sig		1	1	1
0.35	0.52	0.43	sig		0.21	0.24	0.23	sig		0.084	0.081	0.082	non sig		0	0	1
0.3	0.53	0.42	sig		0.17	0.21	0.19	sig		0.062	0.06	0.061	non sig		0	0	1
0.3	0.53	0.42	non sig		0.17	0.21	0.19	non sig		0.062	0.06	0.061	non sig		1	1	1
0.35	0.52	0.43	sig		0.21	0.24	0.23	sig		0.084	0.081	0.082	sig		1	1	1
0.3	0.53	0.42	non sig		0.17	0.21	0.19	non sig		0.062	0.06	0.061	non sig		1	1	1
0.3	0.53	0.42	non sig		0.17	0.21	0.19	non sig		0.062	0.06	0.061	non sig		1	1	1
0.3	0.53	0.42	sig		0.17	0.21	0.19	sig		0.062	0.06	0.061	sig		1	1	1
0.15	0.19	0.18	sig		0.002818	0.002821	0.00282	sig		4.42E-06	3.9E-06	4.16E-06	non sig		1	1	0
0.18	0.23	0.21	sig		0.00461	0.004789	0.0047	non sig		8.97E-06	8.13E-06	8.55E-06	non sig		1	0	0
0.18	0.23	0.21	sig		0.00461	0.004789	0.0047	non sig		8.97E-06	8.13E-06	8.55E-06	non sig		1	0	0
0.15	0.19	0.18	sig		0.002818	0.002821	0.00282	sig		4.42E-06	3.9E-06	4.16E-06	non sig		1	1	0
0.18	0.23	0.21	sig		0.00461	0.004789	0.0047	sig		8.97E-06	8.13E-06	8.55E-06	non sig		1	1	0
0.294	0.531	0.413	sig		0.132	0.165	0.149	sig		0.01	0.01	0.01	sig		1	1	1
0.294	0.531	0.413	sig		0.132	0.165	0.149	sig		0.01	0.01	0.01	sig		1	1	1
0.25	0.39	0.32	sig		0.054	0.058	0.056	sig		0.0043	0.0039	0.004	sig		1	1	1

												1					
0.25	0.39	0.32	non sig		0.054	0.058	0.056	non sig		0.0043	0.0039	0.0041	non sig		1	1	1
0.266	0.447	0.356	non sig		0.086	0.096	0.091	non sig		0.0029	0.0025	0.0027	non sig		1	1	1
0.357	0.592	0.475	non sig		0.259	0.393	0.326	non sig		0.111	0.125	0.118	non sig		1	1	1
0.357	0.592	0.475	sig		0.259	0.393	0.326	sig		0.111	0.125	0.118	non sig		0	0	1
0.286	0.509	0.397	non sig		0.11	0.13	0.12	non sig		0.0052	0.0051	0.0051	non sig		1	1	1
0.357	0.592	0.475	sig		0.259	0.393	0.326	sig		0.111	0.125	0.118	sig		0	0	0
0.357	0.592	0.475	sig		0.259	0.393	0.326	sig		0.111	0.125	0.118	sig		1	1	1
0.357	0.592	0.475	sig		0.259	0.393	0.326	sig		0.111	0.125	0.118	sig		1	1	1
0.33	0.48	0.41	sig		0.143	0.162	0.153	sig		0.04	0.038	0.039	sig		1	1	1
0.33	0.48	0.4	non sig		0.143	0.162	0.153	non sig		0.034	0.032	0.033	non sig		1	1	1
0.33	0.48	0.4	sig		0.143	0.162	0.153	non sig		0.034	0.032	0.033	non sig		0	1	1
0.35	0.44	0.39	sig		0.117	0.127	0.122	sig		0.0161	0.0153	0.0157	sig		1	1	1
0.35	0.44	0.39	sig		0.117	0.127	0.122	sig		0.0161	0.0153	0.0157	sig		1	1	1
0.24	0.37	0.3	sig		0.042	0.044	0.043	sig		0.0024	0.0022	0.0023	sig		1	1	1
0.26	0.44	0.35	sig		0.083	0.092	0.088	sig		0.0118	0.0108	0.0113	sig		1	1	1

0.34	0.46	0.4	sig		0.14	0.15	0.14	sig		0.0271	0.0257	0.0264	non sig		1	1	0
0.3	0.594	0.447	non sig		0.217	0.319	0.266	non sig		0.057	0.065	0.061	non sig		1	1	1
0.28	0.49	0.39	sig		0.096	0.114	0.105	sig		0.0032	0.0031	0.0032	non sig		1	1	0
0.296	0.537	0.417	sig		0.139	0.174	0.156	sig		0.012	0.012	0.012	non sig		0	0	1
0.24	0.39	0.32	non sig		0.034	0.038	0.036	non sig		8.37E-05	8.04E-05	8.2E-05	non sig		1	1	1
0.176	0.248	0.212	sig		0.004132	0.004351	0.004241	non sig		3.91E-08	3.7E-08	3.8E-08	non sig		0	1	1
0.254	0.422	0.338	sig		0.049	0.055	0.052	sig		0.000292	0.000283	0.000288	non sig		1	1	0
0.267	0.458	0.363	sig		0.069	0.08	0.07	non sig		0.001	0.001	0.001	non sig		0	1	1

Appendix III

Table 3. The paper I use to extract data.

Paper citation
A comparison of cod life-history parameters inside and outside of four year-round groundfish closed areas in New England, USA
A dose-dependent relationship between copper burden in female urchin
A meso-predator release of stickleback promotes recruitment of macroalgae in theBaltic Sea
Absence of genetic differentiation in the coral Pocilloporaverrucosa along environmental gradients of the SaudiArabian Red Sea
Abundance, performance, and feeding preference of herbivorous amphipods associated with a host alga-epiphyte system
Acoustic dose-behavioral response relationship in sea bass (Dicentrarchus labrax) exposed to playbacks of pile driving sounds
Acoustic surveys of euphausiids and models of baleen whale distribution in the Barents Sea
Air-Sea CO2-Exchange in a LargeAnnular Wind-Wave Tank and theEffects of Surfactants
An Online Survey of PublicKnowledge, Attitudes, and Perceptions Toward Whales andDolphins, and Their Conservation
AntagonisticEffectsofOceanAcidificationandRisingSeaSurfaceTemperatureontheDissolutionofCoralReefCarbonateSediments
Anti-bacterial activity in egg masses of Melanochlamys diomedea across habitats differing in sediment properties and bacterial load
Assessing reproductive resilience: an example with South Atlantic red snapper Lutjanus campechanus
Assessing the effectiveness of harvest tags in the management of a small-scale, iconic marine recreational fishery in Western Australia
Attachment strength of the herbivorous rockweed isopod, Idotea wosnesenskii (Isopoda, Crustaceae, Arthropoda), depends on properties of its seaweed hos
Background mortality rates for recovering populations of Acropora cytherea in the Chagos Archipelago, central Indian Ocean
Benthic mucilage blooms threaten coralligenous reefs
Better red than dead? Potential aposematism in a harpacticoid copepod Metis holothuriae
Bioaccumulation and trophic transfer of mercury in striped bass (Morone saxatilis)and tautog (Tautoga onitis) from the Narragansett Bay (Rhode Island, USA)
Biological data extraction from imagery e How far can we go? A case study from the Mid-Atlantic Ridge
Biological effects within no-take marine reserves: a global synthesis

Boat- generated turbulence as a potential source of mortality among copepods
Bubble Curtains: Herbivore ExclusionDevices for Ecology and Restorationof Marine Ecosystems?
Building up marine biodiversity loss: Artificial substrates hold lower number and abundance of low occupancy benthic and sessile species
Burial and decomposition of plant pigments in surface sediments of the Baltic Sea: role of oxygen and benthic fauna
Calcification and photophysiology responses to elevated pCO2 in six Halimeda species from contrasting irradiance environments on Little Cayman Island reefs
Cannibalism in red king crab, Paralithodes camtschaticus (Tilesius, 1815): Efets ofhabitat type and predator density on predator functional respons e
Carbon Bioavailability in a HighArctic Fjord Influenced by GlacialMeltwater, NE Greenland
Cheliped morphological variation of the intertidal crab Eriphia verrucosa acrossshores of differing exposure to wave action
Comparing marine primary production estimates throughdifferent methods and development of conversionequations
Comparison of the shell structure of two tropical Thecosomata (Creseis acicula and Diacavolinia longirostris) from 1963 to 2009: potential implications of declining aragonite saturation
Conservation challenges of sharks with continental scalemigrations
Copepod reproductive success in spring-bloom communities with modified diatom and dinoflagellate dominance
Coping with variable and oligotrophic tropical waters: foraging behaviour and flexibility of the Abbott's booby Papasula abbotti
Cryptic invertebrates on subtidal rocky reefs vary with microhabitat structure and protection from fishing
Decadal-scale changes in southern California sciaenids under different levels of harvesting pressure
Density Dependence Drives Habitat Production and Survivorship of Acropora cervicornis Used for Restoration on a Caribbean Coral Reef
Desiccation tolerance and lifting behavior in Crepidula fornicata (Gastropoda)
Development of the EcoQO for the North Sea fish community
Differences in heavy metal concentrations and in the response of the antioxidant system to hypoxia and air exposure in the Antarctic limpet Nacella concinna
Differences in physiological response to increased seawater temperature in nearshore and offshore corals in northern Vietnam
Disruption of endogenous tidal rhythms of larval release linked to food supply and heat stress in an intertidal barnacle
Distribution and fate of trawling-induced suspension of sediments in a marine protected area
Distribution, feeding behaviour, and condition of Cape horse mackerel early life stages, Trachurus capensis, under different environmental

conditions in the northern Benguela upwelling ecosystem
Drivers of fuel use in rock lobster fisheries
Dynamics of European eel landings and stocks in the coastal waters of Estonia
Ecosystem engineering by burrowing crabs increases cordgrass mortality caused by stem-boring insects
Ecotypes as a concept for exploring responses to climate change in fish assemblages
Effects of age class on N removal capacity of oysters and implications for bioremediation
Effects of alga Fucus serratus decline on benthic assemblages and trophic linkages at its retreating southern range edge
Effects of cod and haddock abundance on the distribution and abundance of northern shrimp
Effects of food provisioning on site use in the short-tail stingray Bathytoshia brevicaudata
Effects of hyposalinity on survival and settlement of moon jellyfish (Aurelia aurita) planulae
Effects of Pollution From Anthropogenic Point Sources on the Recruitment of Sessile Estuarine Reef Biota
Effects of solar radiation on barnacle settlement, early post-settlement mortality and community development in the intertidal zone
Efficacy of an established marine protected area at sustaining a queen conch Lobatus gigas population during three decades of monitoring
Elevated pCO2 exposure during fertilization of the bay scallop Argopecten irradians reduces larval survival but not subsequent shell size
Estimating and mitigating the discard mortality of Atlantic cod (Gadus morhua) in the Gulf of Maine recreational rod-and-reel fishery
Evaluating the predictive performance of empirical estimators of natural mortality rate using information on over 200 fish species
Experimental determination of the effects of light limitation from suspendedbagoyster(Crassostreavirginica)aquacultureonthestructure and photosynthesis of eelgrass (Zostera marina)
Fish growth, reproduction, and tissue production on artificial reefs relative to natural reefs
Fitness- related consequences of competitive interactionsbetween farmed and wild Atlantic salmon at differentproportional representations of wild- farm ed hybrids
Growth and condition in harp seals: evidence of density
Growth,mortality,andrecruitmentsignalsinage-0gadidssettling in coastal Gulf of Alaska
Gut fluorescence technique to quantify pigment feeding in Downs herring larvae
Habitat effects of macrophytes and shell on carbonate chemistry and juvenile clam recruitment, survival, and growth

Habitat type and beach exposure shape fish assemblages in the surf zones of ocean beaches
Habitat partitioning between prey soldier crab Mictyris brevidactylus and predatorfiddler crab Uca perplexa
How effective are MPAs? Predation control and ‘spill-in effects’ in seagrass–coral reef lagoons under contrasting fishery management
How do waders perceive buried prey with patchy distributions? The role of preydensity and size of patch
Hyperbenthic food-web structure in an Arctic fjord
Impact of nitrogen chemical form on the isotope signature and toxicity of a marine dinoflagellate
Impact of the diatom-derived polyunsaturated aldehyde 2-trans,4-trans decadienal on the feeding, survivorship and reproductive success of the calanoid copepod Temora stylifera
Impact of tropical forest logging on the reproductive success of leatherback turtles
Impact of Three Bleaching Events onthe Reef Resiliency of Kãneohe Bay,Hawai'i
Importance of patch size variation for the population persistence of a decapod crustacean in seagrass beds
In situ swimming and orientation behavior of spiny lobster (Panulirus argus) postlarvae
Incidence of lesions on Fungiidae corals in the eastern Red Sea is related to water temperature and coastal pollution
Indirect effects of bioturbation by the burrowing sandprawn Callichirus kraussi on a benthic foraging fish, Liza richardsonii
Influence of ontogeny and environmental exposure on mercury accumulation in muscle and liver of male Round Stingrays
Investigating the recent decline in gadoid stocks in the west of Scotland shelf ecosystem using a foodweb model
Large centric diatoms allocate more cellular nitrogen tophotosynthesis to counter slower RUBISCO turnover rates
Life on the edge: environmental determinants of tilefish(Lopholatilus chamaeleonticeps)abundance since its virtual extinction in 1882
Long-term changes (1990−2012) in the diet of striped dolphins Stenella coeruleoalba from the western Mediterranean
Mangrove Methane Biogeochemistryin the Indian Sundarbans: AProposed Budget
Micro-climate and incubation in a fiddler crab species
Modelling larval dispersal of Pecten maximus in the English Channel: a tool for the spatial management of the stocks
Near-future temperature reduces Mg/Ca ratios in the major skeletal components of the common subtropical sea urchin Lytechinus variegatus
New tracer to estimate community predation rates of phagotrophic protists
Night-time predation on post-settlement Japanese black rockfish Sebastes cheni in a macroalgal bed:effect of body length on the predation rate
Non-contact competition in a sessile marine invertebrate: causes and consequences

Nursery habitat availability limits adult stock sizes of predatory coastal fish
Nutrient acquisition strategies in mesophotic hard corals using compound specific stable isotope analysis of sterols
Nutrient availability modifiies species abundance and community structure of Fucus-associated littoral benthic fauna
Padmini Dalpadado1*, Randi B. Ingvaldsen1, Leif Christian Stige2, Bjarte Bogstad1, Tor Knutsen1, Geir Ottersen3, and Bjørnar Ellertsen1
Parasitism, condition and reproduction of the European hake
Persistent border: an analysis of the geographic boundary of an intertidal species
Pingers cause temporary habitat displacement in the harbour porpoise Phocoena phocoena
Population dynamics of corkscrew sea anemones Bartholomea annulata in the Florida Keys
Population metrics in protected commercial sea cucumber populations (curryfish: Stichopus herrmanni) on One Tree Reef, Great Barrier Reef
Predator induced defenses in a salt -marsh gastropod
Quantification of the indirect effects of scallop dredge fisheries on a brown crab fishery
Reduced tenacity during “high-speed” territorial encounters in the intertidal owl limpet, Lottia gigantea: Agonistic escalation increases risk of wash-off
Refuge utilization and preferences between competing intertidal crab speciesop
Relationships between an invasive crab, habitat availability and intertidal community structure at biogeographic scales
Repeatability of egg size in two marine gastropods: brood order and female size do not contribute to intraspecific variation
Response of top shell assemblages to cyclogenesis disturbances. A case study in the Bay of Biscay
Response of two marine bacterial isolates to high CO_2 concentration
Seagrass resilience to waterfowl grazing in a temperate estuary: A multi-site experimental study
Season Exerts Differential Effects ofOcean Acidification and Warming onGrowth and Carbon Metabolism ofthe Seaweed Fucus vesiculosus inthe Western Baltic Sea
Seasonal distribution and reproductive strategy of seahorses
Seaweed structure shapes trophic interactions: A case study using a midtrophic level fish species
Sediment Nitrous Oxide Fluxes AreDominated by Uptake in a TemperateEstuary
Selection of diving strategy by Antarctic fur seals depends on where and when foraging takes place
Selective coral mortality associated with outbreaks of Acanthaster planci L.in Bootless Bay, Papua New Guinea

Sex-specific biochemical and histological differences in gonads of sea urchins (Psammechinus miliaris) and their response to phenanthrene exposure
Signalling function of long wavelength colours during agonistic male–male interactions in the wrasse Coris julis
Simulated terrestrial runoff triggered a phytoplankton succession and changed seston stoichiometry in coastal lagoon mesocosms
Size-related variation in fecundity of European eel (Anguilla anguilla)
Social monogamy in the crab Planes major, a facultative symbiont of loggerhead sea turtles
South polar skuas from a single breeding population overwinter in different oceans though show similar migration patterns
Spatial and temporal distribution of Atlantic mackerel (Scomber scombrus) along the northeast coast of the United States, 1985–1999
Spatial patterns and trends in abundance of larval sandeelsin the North Sea: 1950 2005
Sponge host characteristics shape the community structure of their shrimp associates
Strontium (Sr) uptake from water and food in otoliths of juvenile pike (Esox lucius L)
Surviva bottlenecks in the early ontogenesis of Atlantic herring in coastal lagoon spawning areas of the western Baltic Sea
Temperature variability at the larval scale affects early survival and growth of an intertidal barnacle
Temperature-based spawning habitat selection by capelin (Mallotus villosus) in Newfoundland
The effect of flow speed and food size on the capture efficiency and feeding behaviour of the cold-water coral Lophelia pertusa
The recruitment of Atlantic salmon in Europe
The role of climate and fisheries on the temporal changes in the Bothnian Bay foodweb
The role of larval supply and competition in controlling recruitment of the temperate coral Oculina arbuscula
The specific gravity of mesopelagic fish from the northeastern Pacific Ocean and its implications for acoustic backscatter
The swimming kinematics and foraging behavior of larval Atlanticherring (Clupea harengus L) ar unaffected by elevated pCO2
Thermal windows supporting survival of the earliest life stages of Baltic herring (Clupea harengus)
Towards spatial management of fisheries in the Gulf: benthic diversity, habitat and fish distributions from Qatari waters
Trophic ecology of a resident Yellow-legged Gull (Larus michahellis) population in the Bay of Biscay
Use of Neutral Red in short-term sediment traps to distinguish between zooplankton swimmers and carcasses
Using cross-correlations to assess the relationship between time-lagged pressure and state indicators: an exemplary analysis of North Sea fish population indicators
Using no-take marine reserves as a tool for evaluating rocky-reef fish resources in the western Mediterranean

Variability in growth rates of long-lived black coral Leiopathes sp. from the Azores
Variability in the density and sound-speed of coastal zooplankton and nekton
Variation in recruitment: differentiating the roles of primary and secondary settlement of blue mussels Mytilus spp.
Water temperature and timing of capelin spawning determine seabird diets
Whelk predators exhibit limited population responses and community effects following disease-driven declines of the keystone predator Pisaster ochraceus
Who really matters: Influence of German Bight key bioturbators on biogeochemical cycling and sediment turnover

Appendix IV

Table 4. Summarizing data of the disagreement and overall.

	small	medium	large
disagreement	95	94	125
overall	433	433	433
NHST sig	3	43	95
optimal alpha sig	92	51	30
overall dis	24%		