Pacific PEER
Public Employees for Environmental Responsibility

April 26, 2021

NOAA Section 515 Officer
NOAA Executive Secretariat
Herbert C. Hoover Building – Room 5230
14th and Constitution Avenue, N.W.
Washington, D.C. 20230

Re: Complaint About Information Quality: Bristol Bay Red King Crab

Dear Sir or Madam:

Public Employees for Environmental Responsibility (PEER) hereby submits this Information Quality Complaint pursuant to the Data Quality Act of 2000,[1] the Office of Management and Budget (OMB) Guidelines for Ensuring and Maximizing the Quality, Utility, and Integrity of Information disseminated by Federal Agencies,[2] and the National Oceanic and Atmospheric Administration (NOAA) Information Quality Guidelines.[3]

PEER submits this Complaint on its own behalf as well as on behalf of Dr. C. Braxton Dew, a fisheries biologist who spent 25 years with the National Marine Fisheries Service (NMFS) studying and writing peer-reviewed research papers on red king crab.

The challenged information is material initiated and distributed by NOAA to the public and which reflects the policies of the agency. Moreover, the challenged information is considered "influential scientific, financial, or statistical information" under the Information Quality Act Guidelines in that it has had clear and substantial impact on major public policy and private sector decisions.

As outlined in this Complaint, the challenged material lacks the accuracy, completeness, reliability, objectivity, and integrity required of influential information relied upon as the basis of official decision making. Through this complaint we seek to have noncompliant information rescinded and corrective information distributed.

Summary

In the past half-century, the Bristol Bay red king crab has plummeted from Alaska's most valuable single-species fishery to a remnant population approaching commercial extinction. This stunning turnaround cannot be attributed to any natural phenomena but to blatant scientific obfuscation and falsification by NMFS, an arm of NOAA.

[1] Section 515 of the Fiscal Year 2001 Treasury and General Government Appropriations Act, Pub.L.106-554
[2] Office of Mgmt. & Budget Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies, 67 Fed. Reg. 8452 (Feb. 22, 2002)
[3] IQA_Guidelines_20021014_commerce-noaa-final.pdf

This Complaint details how NMFS paved the way for the collapse by engaging in sampling bias and data falsification, which inflated NMFS annual population estimates and led to a multi-year regime of overfishing.

During the 1970s, NMFS corrupted its standard systematic sampling design by conducting extra, non-random trawl sampling in areas known (from previous surveys) to be prime habitat for large male king crab. This biased sampling resulted in an increase in the apparent abundance of Bristol Bay king crab.

From 1972 to 1978, NMFS population estimates appeared to track a phenomenal (nearly 800%) increase in Bristol Bay legal-male abundance. These inflated population estimates resulted in harvest quotas that doubled every three years during the 1970s to an all-time-record harvest of 130 million pounds in 1980. Then the inevitable happened — the Bristol Bay red king crab population collapsed, and the harvest fell to zero in 1983.

Pressed to explain the population crash in the early 1980s, NMFS attributed the sudden loss of millions of crabs to "a drastic increase in natural mortality" associated with a somewhat subtle and recurrent meteorological regime-shift. However, actual evidence of a causal link between the 1976 regime shift and the abrupt collapse of the Bristol Bay king crab stock never materialized, even after forty years of investigation.

Missing from decades of theorizing about what might have happened to Alaska's king crabs was any inkling that NMFS data were suspect. NMFS contamination of their systematic sampling design with hundreds of non-random trawl catches ensured that the only thing that was systematic was the bias arising from the hunt for large male king crab, intended to beef up annual population estimates. NMFS inflated population estimates, published annually, resulted in excessive harvest quotas, concomitant overfishing and, ultimately, a collapsed stock.

In the mid-1990s, the Length-Based Analysis (LBA) mathematical model, touted as the next big thing in crab management, was launched. Unfortunately, from its inception, the model embraced the NMFS regime-shift agenda, insisting that the collapse was caused, not by overfishing spurred on by NMFS bogus population estimates, but by some undetermined natural-mortality event. This fixation led the model's authors to make untenable statements about "massive die-offs" and to espouse absurdly high natural mortality rates, presumed to be the consequence of some still hypothetical phenomenon such as disease, predation, cannibalism, etc.

Little to no mention was made by the model's authors of the indirect fishing mortality associated with record, directed-fishing harvests and multi-ton cod-ends of commercial trawls stuffed with red king crabs — common enough, beginning in 1980, to earn the nickname, "red bags". Instead, the model defined such ancillary deaths caused by fishing as natural mortality. This ploy, which forced implausible swings in the natural mortality rate, has not passed muster in any annual review by the North Pacific Fisheries Management Council's Scientific and Statistical Committee or by international experts, who characterized the model's rationale as not defensible… ad hoc adjustments "that do not appear to be biologically sensible".

A way to evaluate the effects of NMFS violations of its own sampling design was to purge the hundreds of contaminating, non-random tows from the database, dating back to 1976. Sometime around 2015, after key, old-guard retirements made it practicable, NMFS managers did just that.

A comparison of NMFS pre- and post-purge information (found in the complaint) demonstrates the problems that arise when source population estimates are reduced by some 30 million crabs, but the harvest numbers stay the same. This comparison indicates that, but for NMFS scientific misconduct re the Agency's biased sampling and analysis, the Bristol Bay red king crab stock should have been declared overfished by 1983. As things stand, NMFS has never admitted that overfishing was occurring or that today's nearly depleted stock was ever overfished.

This Complaint is filed through PEER by Dr. C. Braxton Dew, a fisheries biologist with more than 40 years of experience, 25 of which with NMFS. He has logged some 900 dives and several hundred hours of in situ observation of red king crab behavior. The Complaint seeks a correction of the scientific record, including rescission of NMFS stock assessment and fishery evaluation reports (SAFE) for the Bristol Bay red king crab for the years between 2015 and 2020.

I. Introduction

The decade of the 1970s was a boom time for Alaska fishing ports like Kodiak and Dutch Harbor. The Bering Sea commercial harvest of Bristol Bay red king crab (BBRKC), Alaska's most valuable single-species fishery at the time, was doubling every 2.9 years to record levels[4]. Then, in 1981, after a male-only, all-time-record harvest of 130 million pounds, the BBRKC population abruptly collapsed in one of the more precipitous declines in the history of U.S. fisheries management[5]. By 1983 the catch had dropped to zero; and today, some 40 years later, the harvest quota on the BBRKC stock, never declared overfished[6] nor resuscitated with an effective rebuilding plan, is a mere 2.6 million pounds, with the population approaching commercial extinction.[7]

A distinctive signature of the 1981 collapse was the spectacular increase in abundance (nearly 800% during the 1970s) that immediately preceded it[8]. Such increases are atypical of long-lived, late-maturing, K-selected[9] organisms such as Alaska's red king crab. As one former NMFS scientist observed: "What we should wonder about is not so much that the abundance of king crabs declined but that they ever reached such a high abundance level in the first place."[10].
It has been said that the spectacular increase in the BBRKC population during the 1970s was "anomalous" and that it is unlikely that the population can regain such abundance unless

[4] Dew, C. B. 2010a. Podding behavior of adult king crab and its effects on abundance-estimate precision. In: Biology and management of exploited crab populations under climate change. Fig.7, p.144.

[5] Dew, C.B. and R.A. McConnaughey. 2005. Did trawling on the brood stock contribute to the collapse of Alaska's king crab? Ecological Applications, 15(3):919-941. P.919.

[6] Kruse, G.H., Zheng, J. and D.L. Stram. 2010. Recovery of the Bristol Bay stock of red king crabs under a rebuilding plan. ICES Journal of Marine Science. 67(9), p.1870.

[7] https://www.adfg.alaska.gov/static/applications/dcfnewsrelease/1226973814.pdf

[8] Dew, C.B. 2010a, p.147.

[9] Kruse, G.H. http://www.adfg.alaska.gov/fedaidpdfs/RIR.5J.1993.02.pdf , pp.5-6, 8.

[10] Stevens, B.G. 2014. Kings Crabs of the World, p.588.

environmental conditions return to the favorable milieu of the 1970s[11]. However, as revealed in this complaint, it may be more accurate to say that the meteoric rise in BBRKC numbers during the 1970s was based on sampling bias and data falsification, which will not reoccur because those responsible are no longer able to marshal and apply the resources of government to pull the wool over our eyes.

II. The Survey

A. Design

The U.S. National Marine Fisheries Service (NMFS) annual red king crab survey in Bristol Bay and adjoining waters (to 166ºW) is designed to systematically collect a single bottom-trawl sample at the center of each of some 120 stations, each representing a 20 x 20 nautical mile (nm) grid square of 400 nm^2. The Bristol Bay sampling is designed to be unstratified; that is, the spatial distribution of the sampling is uniform over a systematic grid of geographically fixed stations and is not designed to vary with respect to the spatial distribution of the target organism[12]. Crab abundances are calculated by NMFS using an area-swept method[13], where the number of crabs caught per fractional nm^2 covered by the tow is multiplied by the 400 nm^2 of the grid square.

The primary advantage of the systematic design is that, by eliminating investigator bias that may result from decisions as to how many samples to collect and where to collect them, it ensures a random sample. Systematic sampling is not designed to maximize the catch. It is designed to minimize bias and to collect a random sample that is comparable among years. During the 1970s and 1980s, extra, ad hoc, non-design-based sampling defeated the purpose of the NMFS systematic sampling design to provide random, unbiased samples.

B. Actual

During the 1970s and 1980s, the sampling of BBRKC, instead of being systematic as designed, was "frequently augmented" by extra tows at "random locations" within the 400 nm^2 grid squares[14]. Most often, these additional 'prospecting' tows were done after completion of the

[11] Welcome to the NOAA Institutional Repository | , Appendix L pp.17-18, at p.1287-1288 of 1326; BBRKC SAFE October 2020 (npfmc.org) , p.26.

[12] Dew, C.B. and R.G. Austring. 2007. Alaska red king crab: a relatively intractable target in a multispecies trawl survey of the eastern Bering Sea. Fisheries Research 85:165-173. https://meetings.npfmc.org/CommentReview/DownloadFile?p=610b877d-c24d-409e-8904-24b5a938fff6.pdf&fileName=2018_CrabEBSsurvey_DRAFT.pdf . Rpt. pp.3, 58; viewer pp. 10, 65.

[13] Alverson, D.L. and Pereyra, W.T. 1969. Demersal fish explorations in the north-eastern Pacific Ocean—An evaluation of exploratory fishing methods and analytical approaches to stock size and yield forecasts. Journal of the Fisheries Research Board of Canada, 26, pp.1985-2001.

[14] Otto, R.S. 1986. Management and Assessment of Eastern Bering Sea King Crab Stocks, In: G. S. Jamieson & N. Bourne (eds.) North Pacific Workshop on stock assessment and management of invertebrates. Canadian Special Publication of Fisheries and Aquatic Sciences 92, p.88.

regular survey[15] so they could be better focused on known crab concentrations revealed by the survey. Because of these unsanctioned departures from the sampling design, the annual sample collected from the BBRKC population was no longer random; instead, it was increasingly biased toward greater numbers of legal[16] males. Moreover, the annual samples collected from BBRKC habitat, because of unequal and undocumented effort (extra tows that caught no RKC were not counted), were not comparable among years.

III. The Data

A. Data Irregularities

The non-random sampling effort that went into the NMFS BBRKC survey during the 1970s and 1980s — samples which were routinely included in NMFS population estimates[17] — was not inconsequential. In 1979, for example, 108 non-design based prospecting tows (up to nine at a single station, E06) were conducted within 82 Bristol Bay grid squares, which represented a 132% non-random augmentation of the standard-survey sampling effort. This type of non-random sampling represented 60% of all tows made in RKC habitat during 1976-1980[18].

1. Non-Random Sampling

NMFS officials claim that the extra sampling was conducted at "random locations"[19]. However, the fact that the locations were chosen based on the results of earlier surveys invalidates the claim of randomness. In fact, it is common knowledge that the extra sampling over the years was conducted in areas which had yielded high densities of legal male red king crab in the primary survey. For example, the highest densities of legal males in the 1988 and 1989 surveys were collected during August at grid square C08[20], where there were 40 extra tows in 1988 and 34 in 1989 after the regular surveys in June[21].

2. Biased Sample Selection

NMFS officials state that "Catches from all successful tows enter into computations of abundance"[22]. This means that investigators selected for analysis only those extra tows that

[15] Stevens, B.G. and R.A. MacIntosh. 1989. NMFS Processed Report to Industry on the 1989 Eastern Bering Sea Crab Survey, 89-18, p.1
[16] Legal males (or legals) are male RKC equal to or greater than 135 mm in carapace length.
[17] Ibid. p.1.
[18] Dew, C.B. 2010a, Table 1, p.134.
[19] Otto, R.S. 1986, p.88.
[20] Dew, C.B. 2010b. Historical perspective on habitat essential to Bristol Bay red king crab. In: Biology and management of exploited crab populations under climate change. Fig.5 (map), p.392.
[21] Stevens, B.G., R.A. MacIntosh, and K.L. Stahl-Johnson, 1988. NMFS Processed Report to Industry on the 1988 Eastern Bering Sea Crab Survey, 88-23, pp. 2, 26. Stevens, B.G. and R.A. MacIntosh,1989, pp. 1, 34.
[22] Otto, R.S. 1986, p.90.

caught RKC. Extra tows that caught no RKC were deemed unsuccessful and were not included in the station's average abundance. For example, at grid square E06 in 1979, ten tows (one standard tow and nine non-design-based extras) were conducted. If the first (standard) tow was a zero, and three of the nine extra tows caught RKC, these three plus the standard tow were used in calculating the average abundance at Station E06.

a) Effects of Biased Sample Selection

The multiple-tow data (# legal males per tow) for the ten repeated tows at Station E06 in 1979 are: 0, 0, 0, 0, 0, 4, 0, 130, 0, 89. The transparency of NMFS-disseminated literature is inadequate to determine with certainty which of these numbers were used in the 1979 computation of legal-male RKC abundance at Station E06. However, given the NMFS-published design of the systematic survey, we know that the first tow (and only the first tow) was to be used to scale up to the total number of legal RKC estimated to be in the 400 nm^2 grid square E06. In this particular example, the first tow indicated that there were no (zero) legal RKC in grid square E06. But the extra, non-random, prospecting tows present us with a different picture. Using the standard tow (0), plus the successful tows (4, 130, 89), and omitting the unsuccessful (zero) extra tows, as indicated[23], the average number of legals caught at grid square E06 was (0 + 4 + 130 + 89) / 4 = 55.75. Expanding up to the number of legal crab estimated to be in grid square E06, (55.75 / 0.0082 nm^2) × 400 nm^2, results in an estimate of 2.7 million legal RKC in the grid square. That is, if the NMFS survey had been conducted as designed and as publicized by NMFS, grid square E06 would have contributed no (zero) legal male RKC to the 1979 estimate of the total Bristol Bay standing crop. However, as modified by unauthorized departures from the NMFS-published sampling design, the estimate for grid square E06 was inflated to 2.7 million legal crab. In 1979 there were nine grid squares where the first tow caught zero RKC and extra prospecting tows then inflated each of these estimates by several thousand to several million legal RKC. Altogether there were 108 extra tows at 82 grid squares in 1979[24], which inflated the annual estimate to 43.9 million legal male RKC.

B. Effects of Data Irregularities

At this point it should be clear that non-random sampling and sample-selection bias, as practiced by NMFS in the form of more than 200 prospecting tows during the 1970s[25], resulted in BBRKC population estimates that were biased high. It should further be apparent that this unauthorized sampling and concomitant data falsification (the omission of zero-catch tows) led to synthesized and interpreted products, sponsored and disseminated by NMFS, whose utility, objectivity, and integrity were compromised, in violation of NOAA IQA guidelines. The magnitude of this bias can be evaluated only by eliminating all non-design-based tows and presenting the revised data as it would have been if investigators had conducted the sampling as designed; that is, a single tow per grid square.

[23] Otto, R.S. 1986, p.90.
[24] Dew, C.B. 2010a, Table 1, p.134.
[25] Ibid.

1. Abundance Overestimates

Sometime around 2015, NMFS revised the 1975-2015 data base[26] by eliminating the biased-high prospecting tows. This revision left in the data base only the standard, design-based (first) tow in each grid square. The effects of the NMFS data revision can be seen by comparing Table 1 and 2, for which the following explanations apply.

Column 1: Year

Column 2: Annual estimates of legal males provided by the NMFS survey. These values represent the population size at time zero (No). In Table 1, these are the original, inflated numbers submitted to the NPFMC and used to set the Guideline Harvest Level for each year.

Column 3: Population size of legals at time t ($Nt = No\ e^{-M\,t}$), after the annual rate of natural mortality (M = 0.2) has operated on the population for the four months (t = 4/12 year) between the survey (June) and the beginning of the fishing season (Oct).

Column 4: Commercial (retained) catch (C) or harvest of legal male crabs. The retained catch for a given year is the only number that does not change from Table 1 to Table 2.

Column 5: Utilization rate (u) expressed as the retained catch (C) as a proportion of the source population (Nt). Utilization rates underestimate the impact of man's fishing because they include only the retained harvest of legal crabs and do not include pot and trawl bycatch of undersize males, females, and prohibited legals[27].

Column 6: Instantaneous rate of fishing mortality (F), which is separate and distinct from the rate of natural mortality (M = 0.2). Together, F + M = Z, or total mortality. A biased- low estimate of F can be calculated from the utilization rate as –Ln (1 – u).

[26] Dr. Robert Foy, Director, Alaska Fisheries Science Center: email to Dr. Braxton Dew, Wed Jul 18, 2018, 2:40 PM: "Attached is the entire time series for abundance and biomass currently used in the assessment."
[27] Ricker, W.E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations. Bulletin 191, Fisheries Research Board of Canada, p.5.

Table 1 Year	ORIGINAL Number Of Legal Males (No)	M = 0.20 Legals 4/12 Year Later (Nt)	Harvest (C)	Utilization Rate u = C/Nt	Fishing Mortality Rate F = -Ln(1 - u)
1975	21,000,000	19,645,647	8,745,294	0.45	0.59
1976	32,700,000	30,591,078	10,603,367	0.35	0.43
1977	37,600,000	35,175,063	11,733,101	0.33	0.41
1978	46,600,000	43,594,626	14,745,709	0.34	0.41
1979	43,900,000	41,068,757	16,808,605	0.41	0.53
1980	36,100,000	33,771,802	20,845,350	0.62	0.96
1981	11,300,000	10,571,229	5,307,947	0.50	0.70
1982	4,700,000	4,396,883	541,006	0.12	0.13
1983	1,500,000	1,403,260	0		

Table 2 Year	REVISED Number Of Legal Males (No)	M = 0.20 Legals 4/12 Year Later (Nt)	Harvest (C)	Utilization Rate u = C/Nt	Fishing Mortality Rate F = -Ln(1 - u)
1975	22,256,963	20,821,544	8,745,294	0.42	0.54
1976	36,352,392	34,007,917	10,603,367	0.31	0.37
1977	36,088,155	33,760,721	11,733,101	0.35	0.43
1978	38,527,112	36,042,382	14,745,709	0.41	0.53
1979	23,642,348	22,117,582	16,808,605	0.76	1.43
1980	37,479,518	35,062,351	20,845,350	0.59	0.90
1981	9,673,906	9,050,007	5,307,947	0.59	0.88
1982	4,002,738	3,744,589	541,006	0.14	0.16
1983	1,287,101	1,204,092	0		

When comparing the original, NMFS-disseminated data in Table 1 and the revised data in Table 2, the 1977-1979 trend of increasing divergence between the original and the revised population estimates is notable. In 1977 (Table 1) the original population estimate was larger than the revised 1977 (Table 2) estimate by 4.2 percent; in 1978 the original was larger by 21 percent; and in 1979 it was larger by 86 percent. Altogether, approximately 30 million legal male red king crab disappeared from the 1977-1979 ledgers after the purge of biased data from the unauthorized, extra tows. The NMFS data revision, in large part, answered the questions asked by many: How did the crab reach such high abundance levels leading up to their collapse[28]?

[28] Stevens, B.G. 2014. Kings Crabs of the World, p.588.

Where did tens of millions of crabs go[29]? The answer is that they probably never existed except as part of a scheme to inflate NMFS population estimates.

2. Overfishing

A key question underlying the 1981-1983 collapse of BBRKC is whether the collapse was caused by overfishing (F) or by natural mortality (M). A definition of overfishing provided by NMFS in 1999 set the Maximum Fishing Mortality Threshold equal to F = M = 0.20 for king crab[30]. Although this might seem overly conservative, an F that equals M and is operative for a year on the exploited part of the population effectively doubles the mortality the species has evolved to withstand and reduces the life expectancy and duration of the reproductive phase by half[31]. Another overfishing threshold was provided by the Alaska Board of Fisheries (BOF), whose 1996 harvest strategy specified that the maximum harvest rate of legal males (u) would be reduced from 60% to 50%[32] (u = 0.50, F = - Ln (1 – u) = 0.69).

Because the impact of a given harvest level increases as the estimated size of the source population is revised lower, problems arise when the source population estimates are reduced by millions of crabs, but the harvest numbers stay the same. Using 1979 as an example, Table 1 shows an initial population size of 43.9 million legal crabs, reduced to 41.1 million after four months of natural mortality, and a harvest of 16.8 million legal males. This resulted in a utilization rate of u = 16.8 / 41.1 = 0.41 and a fishing mortality rate of F = - ln (1 - u) = 0.53. Only in 1980 (Table 1) was there an indication of substantive overfishing (u = 0.62}, according to the limit (u >0.50) set by the BOF.

However, when the data base is purged of biased data, as in Table 2, we have an alarming situation. Now overfishing is obvious, with u = 0.76 and F = 1.43. This means that directed fishing in 1979 took 76% of the estimated legal stock, which was being killed (F) and dying (M) at a rate of Z = F + M = 1.43 + 0.2 = 1.63, resulting in the loss of (1 – $e^{-1.63}$) = 80.4% of the legal males on an annual basis. The fishing Z was more than 8 times the non-fishing Z, where Z = M = 0.20. The revised F was 2.7 times the original 1979 F calculated from NMFS-disseminated data (Table 1). These metrics greatly exceed the NMFS Fishery Management Plan Amendment 7 guidance of F = M = 0.20 and the BOF cap of u = 50% on the legal harvest.

For those who believe that F = M is too conservative, it should be understood that the reproductive potential of the BBRKC stock is routinely overestimated (by up to a factor of 2) by

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[29] Loher, T. and D.A. Armstrong. 2005. Historical changes in the abundance and distribution of ovigerous red king crabs (Paralithodes camtschaticus) in Bristol Bay (Alaska), and potential relationship with bottom temperature. Fisheries Oceanography 14:292-306.

[30] P.18, 25 (actual), p.21, 28 (viewer). noaa_18203_DS1 (1).pdf

[31] https://www.fishbase.de/rfroese/revisiting_faf12102.pdf , p.13.

[32] Zheng J., M. S. M. Siddeek. Bristol Bay red king crab stock assessment in fall 2018.North Pacific Fisheries Management Council. P.10.

investigators and modelers who assume that BBRKC can molt and mate in the same year[33]. Because of this, setting F = M results in an impact that may overstretch the productivity of the stock[34], and many of the world's fisheries scientists caution that F = M is not a target but a limit — a reference point that is not to be exceeded[35].

3. Overfished (Collapsed) Population

After exceeding the contemporary BOF overfishing limit (u = 0.50) by more than 50 percent in 1979, the crab fleet, relying on NMFS inflated population estimates, went on to overfish the BBRKC stock during 1980 (u = 0.59, F = 0.90) and 1981 (u = 0.59, F = 0.88), thus imposing a three-year average fishing mortality rate of F = 1.07 on the stock. Perhaps more troubling is a 3-year average F/M ratio of 5.35, higher than any of the 45 ICES stocks reviewed in 2014 by international fisheries scientists[36]. After three consecutive years of overfishing, it is not unexpected that the BBRKC population collapsed to an obviously overfished state and the fishery was closed in 1983.

Although these rates are sufficiently high to define an extended period of overfishing, they do not tell the whole story because they are *utilization* rates, which consist solely of the retained catch or harvest (C, Tables 1 and 2) from the directed BBRKC fishery. Utilization rates do not account for mortality associated with the RKC bycatch and discards from other-species pot fisheries (e.g., Tanner crab, snow crab, and Pacific cod), which were estimated to be 12-13 times the retained catch during the 1982-1983 season[37]. More importantly, these utilization rates do not account for RKC bycatch mortality in the Bering Sea bottom-trawl fisheries for Pacific cod and various flatfish species. Multi-ton cod-ends of commercial trawls stuffed with king crabs were common enough during the 1980s to earn the nickname, "red bags" [38]. If we were to account for the fishing mortality caused by the Bering Sea trawl fisheries and all pot fisheries, we would then have tables of *exploitation* rates, which would be substantially higher than the utilization rates in Tables 1 and 2. An honest assessment of the impact of fishing would present exploitation rates

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[33] Zhou, S., A.D.M. Smith, A.E. Punt, et al. 2010 Ecosystem-based fisheries management requires a change to the selective fishing philosophy. Proceedings of the National Academy of Sciences. 107(21):9485-9486, p.9487. Dew, C.B. and R.A. McConnaughey. 2005., p.934. Dew, C.B. 2010b. p.394.

[34] https://www.fishbase.de/rfroese/revisiting_faf12102.pdf , p.13.

[35] Beddington, J.R. and J. Cooke. 1983. The potential yield of previously unexploited stocks. FAO Fisheries Technical Paper No. 242. 63 pp. MacCall, A.D. 2009. Depletion-corrected average catch: a simple formula for estimating sustainable yields in data-poor situations. ICES Journal of Marine Science 66:2267-2271. Pikitch, E., P.D. Boersma, I.L. Boyd, et al. Little Fish, Big Impact: Managing A Crucial Link in Ocean Food Webs. Lenfest Ocean Program, Washington D.C. 208 pp. Walters, C. and S.J.D. Martell. 2002. Stock assessment needs for sustainable fisheries management. Bulletin of Marine Science 70:629-638. Walters, C. and S.J.D. Martell. 2004. Fisheries Ecology and Management. Princeton University Press, Princeton.

[36] https://www.fishbase.de/rfroese/revisiting_faf12102.pdf , p.9.

[37] Griffin, K.L., M.F. Eaton, and R.S. Otto. 1983. An observer program to gather in-season and post-season on-the-grounds red king crab catch data in the southeastern Bering Sea. Contract 82-2. Unpub. Doc. Available from North Pacific Fisheries Management Council, Anchorage, Alaska USA.

[38] https://archive.fisheries.noaa.gov/afsc/Publications/misc_pdf/DewMcConnRKC.pdf Figs.7, 8.

(deaths from all fishing activities) instead of utilization rates (deaths of harvested legal males only). Instead, NMFS and ADFG investigators recast the deaths from fishing bycatch (F) as part of natural mortality (M).

3. Conclusions

In violation of NOAA Information Quality Act (IQA) guidelines, the collection and analysis of original data was not done according to documented procedures, or in a manner that reflected standard practices accepted by the relevant scientific communities. Biased data collection (non-random prospecting tows) and biased data selection (selection of "successful", non-zero tows) led to synthesized and interpreted products, sponsored and disseminated by NMFS, whose utility, objectivity, and integrity were compromised, in violation of NOAA IQA guidelines. NMFS dissemination of this influential information to the North Pacific Fisheries Management Council (NPFMC), and others, led to a multiple-year regime of overfishing during the late 1970s and early 1980s, immediately preceding the collapse of the BBRKC stock.

IV. The Model

1. Misrepresentation of Mortality

The NOAA Information Quality Act guidelines state, "…. transparency – and ultimately reproducibility – is a matter of showing how you got the results you got." The North Pacific Fisheries Management Council (NPFMC) and Crab Plan Team (CPT) model (also known as the National Marine Fisheries Service /Alaska Department of Fish and Game (NMFS/ADFG) model) used in the management of the BBRKC stock since 1995, has done an abysmal job of explaining the model's biggest quirk: namely, the model assumes, almost covertly and without supporting data or rationale, that all "indirect" fishing mortality (i.e., all crabs killed as pot and trawl bycatch) is included in the model as M, or natural mortality[39]

Furthermore, according to NOAA Information Quality Act guidelines, objectivity ensures that information is accurate, reliable, and unbiased; that information products are presented in an accurate, clear, complete, and unbiased manner; and that analytic results are developed using commonly accepted scientific methods. The annual NPFMC Stock Assessment and Fishery Evaluation (SAFE) reports, based on the NMFS/ADFG model, satisfy none of these requirements.

The NMFS/ADFG model employed by the NPFMC to manage what used to be Alaska's most valuable single-species fishery may be the only fisheries model in the world that so profoundly conflates man's fishing (F) with natural mortality (M). From the outset, NMFS/ADFG modelers

[39] Zheng, J. and G.H. Kruse. 2002. Retrospective length-based analysis of Bristol Bay red king crabs: model evaluation and management implications. In: Crabs in Cold Water Regions: Biology, Management and Economics. Univ. of Alaska Sea Grant, AK-SG-02-01, Fairbanks. 876 pp. P.484.

quietly lumped all pot and trawl bycatch mortality, historically defined as fishing mortality (F)[40], into a category best described as 'unacknowledged fishing' and then treated this bycatch as natural mortality (M). However, it is well known that trawl and pot bycatch mortality together often dwarf the mortality represented by the retained catch[41]. This slight-of-hand by model authors is starkly at odds with historical precedent as to the separation and strict segregation of F and M.

Traditional texts[42] on fisheries population dynamics instruct readers that mortality within a fish (or crab) population is divided into two discrete, non-overlapping categories: 1) fishing mortality (F) and 2) natural mortality (M), which includes everything but man's fishing. After all, the object of these studies is to evaluate the impact of *fishing*, not some mixture of F and M. These categories are mutually exclusive, and any mixing of the two, into an amalgam, say, of fishing-bycatch mortality and natural (non-fishing) mortality, is unacceptable, simply because the quantities F and M, as well as the system of relationships and equations based on them, lose their meaning.

The Center of Independent Experts (CIE) was established in 1998 to provide external, independent, and expert reviews of the agency's influential science used for policy decisions. The CIE process satisfies peer review standards as specified in the MSA provision National Standard 2 guidelines. These guidelines specify that peer review is an important factor in the determination of best scientific information available[43]. In 2006 a CIE review of the NMFS/ADFG model advised its authors that:

> *".... M, as estimated in the red king crab assessments, is actually a compound of natural mortality and indirect (by-catch) fishing mortality. It is highly desirable to separate these components ..."*[44]

This admonishment has been ignored by NMFS/ADFG modelers during the fifteen years since 2006, when it was written into a NMFS-sponsored CIE peer review of the model.

The total reliance of the regime-shift theory on natural mortality is obvious from an early (1986) post-collapse synopsis of the theory provided by the Director of the NMFS-Kodiak Shellfish Laboratory who oversees the annual BBRKC trawl survey[45].

> *"Increased rates of natural mortality were undoubtedly the major cause of recruitment failure .... I. conclude that directed or undirected fishing [e.g., bottom trawling] has not*

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[40] Ricker, W.E. 1975, p.9.
[41] Dew, C.B. and R.A. McConnaughey 2005. Figs. 7, 8, p.927.
[42] E.g., Ricker, W.E. 1975.
[43] https://www.st.nmfs.noaa.gov/science-quality-assurance/cie-peer-reviews/index
[44] Bell, M.C. 2006. Review of Alaska Crab Overfishing Definitions. Univ. of Miami Independent System for Peer Review, pp.20-21.
[45] Otto, R.S. 1986. P.104-105.

been a major cause of population decline in Bristol Bay red king crab…. Management measures failed to prevent recent declines in landings because causes of declines in abundance are not related to fishing, and hence largely beyond control."

Note how this statement, unlike the NMFS/ADFG model, treats nature and man's fishing as separate sources of mortality.

Convincing evidence as to the sources and operative mechanisms for the hypothetical onslaught of natural mortality has not materialized, despite extensive research conducted during the past forty years[46] Regime-shift proponents, i.e., NMFS/ADFG modelers, have bypassed this obstacle by misclassifying peaks in fishing-bycatch mortality as natural mortality. Thus, any fishing mortality spikes caused, for example, by the documented onset of commercial trawling in newly breached sanctuaries during the late 1970s and early 1980s[47] are interpreted as natural deaths. The NMFS/ADFG modelers do this by cranking up "natural" mortality by a factor of 5X during 1980-1984 to account for the surge in bycatch (fishing) mortality as the BBRKC population became overfished and bottom trawling in the no-trawl sanctuaries ramped up. The following excerpt is an example:

"For males, natural mortality was M = 0.18 per year except for the period 1980-84, when it was 0.8966; for females, M = 0.2369 except for 1980-84, when it increased to 1.1802" [48].

Different model scenarios employed more complex manipulations of natural mortality:

[46] E.g., Bakkala, R.G. 1981. Population characteristics and ecology of yellowfin sole. Pages 553–574 in D. W. Hood and J. A. Calder, editors. The Bering Sea shelf: oceanography and resources, Volume 1. NOAA Office of Marine Pollution Assessment, University of Washington Press, Seattle, Washington, USA; Haflinger, K.E. and C.P. McRoy. 1983. Yellowfin sole (Limanda aspera) predation on three commercial crab species (Chionoecetes opilio, C. bairdi, and Paralithodes camtschatica) in the southeastern Bering Sea. Final report to National Marine Fisheries Service, Contract 82-ABC-00202. 28 pp; Jewett, S.C. and C.P. Onuf. 1988. Habitat suitability index models: red king crab. U.S. Fish and Wildlife Service Biological Report 82(10.153). 34 pp; Livingston, P.A. 1989. Interannual trends in Pacific cod, Gadus macrocephalus, predation on three commercially important crab species in the eastern Bering Sea. Fishery Bulletin 87:807-827; Kruse,G.H. and J. Zheng. 1999. Are changes in Bering Sea crab and groundfish populations related? Pages143-148 in Ecosystem Approaches for Fisheries Management (extended abstract). University of Alaska Sea Grant Program Report AK-SG-99-01; Dew, C.B., and R.A. McConnaughey. 2005. Did trawling on the broodstock contribute to the collapse of Alaska's king crab? Ecological Applications 15:919–941. Urban, D.J. 2010. Pacific cod predation on Tanner crab in Marmot Bay, Alaska. Pages 341-359 in Biology and Management of Exploited Crab Populations under Climate Change. Alaska Sea Grant, AK-SG-10-01, Fairbanks. 562 pp. http://www.afsc.noaa.gov/Publications/misc_pdf/DewMcConnRKC.pdf;

[47] Dew, C.B. and R.A. McConnaughey, 2005, pp.919-941.

[48] Zheng J., M. S. M. Siddeek. Bristol Bay red king crab stock assessment in fall 2020.North Pacific Fisheries Management Council. P.18.

"M values are 0.7459 during 1980-1984 and 0.18 for the other years for males, and 1.172 during 1980-1984 and 0.3124 during 1976-1979 and 1985-1993 and 0.18 for the other years for females"[49].

There is no data-based justification for these adjustments. Modelers simply resorted to arbitrarily dialing up the model's M-values until the required numbers of male and female crabs disappeared. Modelers could have just as easily (and more appropriately) increased the F-values, but that would have been inconsistent with the regime-shift theory.

This questionable accounting did not go over well with the NPFMC Scientific and Statistical Committee (SSC), which oversees work on the Crab Plan Team's model and whose members have pressured the modelers for years to avoid using M as a variable to obtain better model fits. Nor did these manipulations pass muster in 2006 with three international (UK, AU, NZ) CIE reviewers.

"Without data …., it is not defensible to use ad hoc model adjustments to infer changes in M on the basis of model fit."[50]

"The use of different natural mortality levels for 3 different periods for males and 4 different periods for females (Zheng 2006[51]) does not appear to be biologically sensible."[52]

"Attempts to estimate different M for different time periods in a stock assessment (Zheng 2004[53]) are ill-advised."[54]

Knowledgeable scientists[55] specifically warn against using M as a fix for a retrospective pattern (e.g., the 1980-1984 mortality spike). Unlike the NMFS/ADFG model, M is typically held

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[49] Ibid. p.18.

[50] https://www.st.nmfs.noaa.gov/Assets/Quality-Assurance/documents/peer-review-reports/2006/2006_06_01%20Bell%20Bering%20Sea%20Aleutian%20Islands%20crab%20overfishing%20definitions%20report.pdf , p.20.

[51] 2006 SAFE report, Appendix B, p.190 of 252: Various scenarios, each with a different regime of natural mortality (M) were examined. Results from scenario A(1), the base scenario, have been used for management during the past 12 years since 1995; A(1) relies on 4 levels of M for females and 3 levels of M for males.

[52] https://www.st.nmfs.noaa.gov/Assets/Quality-Assurance/documents/peer-review-reports/2006/2006_05_12%20Caputi%20Bering%20Sea%20Aleutian%20Islands%20crab%20overfishing%20definitions%20report.pdf pp.5-6, 14.

[53] 2004 SAFE report, Appendix B, p.458 of 520: Four scenarios, each with a different regime of natural mortality (M) were examined. Results from scenario A1-1 have been used for management during the past 10 years; A1-1 is the base scenario in this report. A1-1: 4 levels of M for females and 3 levels of M for males.

[54] https://www.st.nmfs.noaa.gov/Assets/Quality-Assurance/documents/peer-review-reports/2006/2006_05_12%20Cordue%20Bering%20Sea%20Aleutian%20Islands%20crab%20overfishing%20definitions%20report.pdf p.9.

[55] Legault, C.M. and M.C. Palmer.2016. In what direction should the fishing mortality target change when natural mortality increases within an assessment. Canadian Journal of Fisheries and Aquatic Sciences 73(3):349-357.

constant over years and ages; but if investigators opt to vary M, they should justify their M-values with reliable empirical data from, say, a comprehensive tagging study or an unexploited population (for which Z = M). The NMFS/ADFG modelers have no such data, have never had such data, and have ignored this advice. Instead, the NMFS/ADFG modelers unapologetically use M to account for mortality spikes such as that which occurred coincident with the 1980 onset of bottom trawling in previously untrawled BBRKC habitat.[56] Over several decades, NMFS/ADFG modelers have maximized M by using it to account for crabs killed by fishing, while minimizing F by largely restricting it to the retained catch composed only of legal males. At best this is misguided; at worst, it is fraudulent.

2. Model Dilemma — Too Many Crabs

Almost immediately after the BBRKC collapse in the early 1980s, the model's agenda became clear. The model was to reinforce the regime-shift story by killing off tens of millions of RKC without using fishing mortality to do it. The problem, of course, was the same as that which had caused the overfishing. That is, the system was awash in excess (but fake) RKC caused by NMFS biased survey sampling and NMFS dissemination of falsified and inflated population estimates. Shortly after the LBA (Length-Based Analysis) model was initiated as a management tool in 1995, NMFS/ADFG modelers realized that it was difficult to maintain their credibility as scientists while trying to get rid of millions of adult RKC using natural mortality. The overseers of the modeling effort, known as the Scientific and Statistical Committee (SSC), which reports to the North Pacific Fisheries Management Council (NPFMC), advised the NMFS/ADFG modelers (almost annually) to justify the outlandish M-values used to fit the model to the NMFS-inflated data.

Example, Scientific and Statistical Committee:

> *"We request that the authors continue to explore a model that uses a constant M over time or other ways of accounting for the large biomass peak in the late 1970s / early 1980s and the subsequent steep decline in crab abundance. It remains unclear whether the decline was due to increased mortality (e.g., predation by Pacific cod), a shift in productivity, or a fishing impact."*[57].

Modelers' response:

> *"The model has a difficulty to get rid of crabs with a constant M of 0.18 during the early 1980s."*[58].

In other words, using reasonable values for M, it was not possible to kill off the huge numbers of crabs assumed to be in the system — an assumption based on the NMFS bloated and biased

[56] Dew, C.B. and R.A. McConnaughey. 2005, p.919.
[57] https://www.npfmc.org/wp-content/PDFdocuments/resources/SAFE/CrabSAFE/CRABSAFE09.pdf , p.138.
[58] https://www.npfmc.org/wp-content/PDFdocuments/resources/SAFE/CrabSAFE/CRABSAFE2010.pdf , p.142.

population estimates of the 1970s. The obvious alternative would be to take the advice of knowledgeable scientists to keep M constant, as other scientists advise, and to use F as the most likely source of the 1980-1984 mortality spike. However, when this was attempted in 2019, the model output included a 1981 estimate of fishing mortality that was considered by the SSC and the modelers to be "unbelievably high"[59]. It is telling that professional modelers and statisticians recoiled from extremely high fishing mortality rates associated with a stock in the throes of collapse after reaching dizzying heights and being subjected to a frenzy of overexploitation, both by directed (pot) fishing and undocumented bycatch mortality from industrial-scale bottom trawling[60]. At any rate, it is expected that the problem of "unbelievably high" rates will be ameliorated by the recent editing out of nearly 30 million bogus legal male RKC from the flawed and biased NMFS 1977-1979 data base (Tables 1 and 2).

Dropping the regime-shift agenda should solve the modelers problem. Doing it right (according to Ricker) should be a lot simpler than fabricating outlandish, time-variable values for M. It will be easier to simply keep M constant for each sex (there is no evidence to suggest otherwise), calculate a sex-specific Z for each year (from NMFS annual abundance estimates), and obtain F by subtraction (F = Z – M). Of course, when this is done, the need to characterize the 1976-77 regime shift as an ecological disaster for BBRKC will likely disappear, along with the regime-shift theory.

V. Remedies

Understanding that a trusting body of scientists and members of the public have relied on the biased data provided by NMFS for more than 40 years, the data revisionists, modelers, scientists, and agency officials are now faced with the following obligations.

1. Issue a public statement, posted on official websites, declaring that sometime around 2015 the NMFS legal-male population estimates, which were used to set annual, pre-collapse Guideline Harvest Levels, underwent major revision under the supervision of the NMFS/Kodiak facility. As part of the revision process, a great deal of non-random and biased trawl data (several hundred tows), included in earlier estimates, were purged from the data base. Details of the revisions and, more importantly, their effect on previous management decisions and theories, are lacking and must be documented for the affected public and scientists who may be forced to issue errata for previously published journal papers. Also, the reasons for such pervasive and disturbing revision should be clearly stated: e.g., unauthorized departures from the NMFS systematic sampling design; data falsification, data enhancement, data fabrication, etc. Moreover, key elements of the NPFMC, such as the Crab Plan Team and the Scientific and Statistical Committee should acknowledge, in their annual SAFE reports, that theories (e.g., regime-shift induced reduction in stock productivity theory) and conclusions based on the original data are now suspect or wrong.

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[59] https://www.npfmc.org/wp-content/PDFdocuments/resources/SAFE/CrabSAFE/2019/SAFE_2019_Complete.pdf , p.135.
[60] Dew and McConnaughey. 2005. Fig.7, p.927.

2. Include in the public statement acknowledgement that the data base revisions conducted by NMFS resulted in approximately 30 million illusory legal males being eliminated from the 1977-1981 original population estimates. When these new, lower estimates were paired with their old harvest rates a distinct period of overfishing was revealed. During at least three consecutive years (1979-1981) fishing mortality ranged between F = 0.88 to F = 1.43 (M = 0.20), until the stock collapsed to an obviously overfished state at less than 5% of its estimated peak abundance a few years previously (Table 2).

3. Acknowledge that overfishing during the late 1970s and the population's collapse in the early 1980s means that the BBRKC population has been in an overfished state since the early 1980s.

4. Revise and correct any and all combinations of fishing mortality (F) and natural mortality (M) so that there is a strict separation between F and M in accordance with traditional fisheries texts[61]. Furthermore, the revisions, unlike SAFE report presentations during the past 25 years, must be consistent with NOAA IQA requirements. That means the information must be accurate, reliable, and unbiased; the information products must be presented in an accurate, clear, complete, and unbiased manner; and the analytic results must be developed, using commonly accepted scientific and statistical methods. It should be unambiguous and obvious that all pot and trawl bycatch mortality, as well as the retained catch, must be included in the LBA model as F, not M. For more than 20 years, the model has incorrectly allocated bycatch mortality to M, and then, when trawling invaded the no-trawl sanctuaries in the late 1970s and early 1980s, claimed that the trawl-killed crab died of natural mortality.

5. Heed the unanimous, peer-review comments of the 2006 CIE reviewers and the advice of other scientists, as well as the periodic urgings of the North Pacific Fisheries Management Council's Scientific and Statistical Committee, to cease inflating natural mortality rates to account for increased fishing mortality during 1980-1984, or any other time.

6. Revise and correct SAFE reports from 2015 (approximately the year of the NMFS/Kodiak data revision) through 2020 to include items 1 through 5 above. Each of the 2015-2020 SAFE reports, specifically the BBRKC assessment, must include a discussion explaining that, because of extensive data revisions and a 40-year dearth of confirmatory evidence, the regime-shift theory, which requires that millions of missing adult BBRKC died from an as-yet undocumented source of natural mortality during the early 1980s, is no longer a valid, reasonable, or necessary hypothesis vis-à-vis the collapse of BBRKC. Importantly, given the revised data indicating that the BBRKC stock has been overfished since the late 1970s or early 1980s, as clarified in this complaint, the Stock Status Summaries in each SAFE report should drop the following annual assurances:

[61] E.g., Ricker, W.E. 1945.

The stock was not overfished and overfishing did not occur during the year; nor is the stock projected to be in an overfished condition in the future.

Based on the information we have presented in this Complaint, the above statement is patently false and has been for more than 40 years. Furthermore, no mortality from fishing activities (e.g., pot-bycatch mortality, trawl-bycatch mortality, or retained catch) shall be incorrectly specified as natural mortality (M). A list of SAFE reports available for revision follows.

Zheng J., M.S.M. Siddeek. Bristol Bay red king crab stock assessment in fall 2015. *Stock Assessment and Fishery Evaluation Report for the King and Tanner Crab Fisheries of the Bering Sea and Aleutian Islands Regions*, 2015 Anchorage, AK North Pacific Fishery Management Council (p. 15-17; p.181-294) 952 pp.

Zheng J., M.S.M. Siddeek. Bristol Bay red king crab stock assessment in fall 2016. *Stock Assessment and Fishery Evaluation Report for the King and Tanner Crab Fisheries of the Bering Sea and Aleutian Islands Regions*, 2016 Anchorage, AK North Pacific Fishery Management Council (p. 16-18; p. 43-123) 899 pp.

Zheng J., M.S.M. Siddeek. Bristol Bay red king crab stock assessment in fall 2017. *Stock Assessment and Fishery Evaluation Report for the King and Tanner Crab Fisheries of the Bering Sea and Aleutian Islands Regions*, 2017 Anchorage, AK North Pacific Fishery Management Council (p. 18-20; p.159-308) 1620 pp.

Zheng J., M. S. M. Siddeek. Bristol Bay red king crab stock assessment in fall 2018. *Stock Assessment and Fishery Evaluation Report for the King and Tanner Crab Fisheries of the Bering Sea and Aleutian Islands Regions*, 2018 Anchorage, AK North Pacific Fishery Management Council (p. 16-19; p.133-272) 1475 pp.

Zheng J., M. S. M. Siddeek. Bristol Bay red king crab stock assessment in fall 2019. *Stock Assessment and Fishery Evaluation Report for the King and Tanner Crab Fisheries of the Bering Sea and Aleutian Islands Regions*, 2019 Anchorage, AK North Pacific Fishery Management Council (p. 16-18; p. 128-292) 1241 pp.

Zheng J., M. S. M. Siddeek. Bristol Bay red king crab stock assessment in fall 2020. *Stock Assessment and Fishery Evaluation Report for the King and Tanner Crab Fisheries of the Bering Sea and Aleutian Islands Regions*, 2019 Anchorage, AK North Pacific Fishery Management Council p.1- 204.

Affected Persons

The professional career of Dr. C. Braxton Dew spans more than 40 years and includes ten years as a fisheries biologist and expert witness on the Hudson River. In Alaska he spent 25 years with the National Marine Fisheries Service (NMFS) studying and writing peer-reviewed research papers on red king crab. After some 900 logged dives and several hundred hours of in situ observation, Dew was the first to describe aspects of red king crab behavior that had profound implications as to the precision claimed for abundance estimates from NMFS' annual Bristol Bay bottom-trawl survey. As an "affected person", multiple papers written by Dr. Dew and published in international journals are negatively affected by the data irregularities described in this complaint.

PEER is a non-profit organization chartered in the District of Columbia with the mission to hold government agencies accountable for enforcing environmental laws, maintaining scientific integrity and upholding professional ethics in the workplace. PEER is an "affected person" in that PEER 1) has been an active participant in wildlife management issues confronting NOAA; 2) PEER is a principal watchdog organization tracking NOAA compliance with its governing statutes and rules designed to ensure the scientific quality of NOAA technical work, including compliance with the requirements of the Information Quality Act; and 3) on behalf of PEER members who are current and former NOAA employees, PEER has a vital interest in ensuring that NOAA comply with applicable laws, regulations and its own policies.

Pursuant to the NOAA Guidelines, we look forward to your response to this Complaint within 60 calendar days. Thank you in advance for your prompt attention to this matter.

Sincerely,

Jeff Ruch
PEER Pacific Director