

North Totten Inlet Mussel Culture Proposal

Response of the Independent Technical Review Committee (ITRC) to Aquatic Environmental Sciences 12/14/01 Comments on the 11/01/01 Recommendations of the ITRC re:

Proposed Scope of Work and Protocols for Aquatic Environment Technical Studies

February 13, 2002

The Independent Technical Review Committee (ITRC) retained by Thurston County and Taylor Resources completed their review and recommendations with respect to the Scope of Work and Protocols for aquatic environment technical studies to address the North Totten Inlet Mussel Culture Proposal. These recommendations were submitted to the County and Taylor Resources in the form of a 15-page memo dated 11/01/01. Taylor Resources' technical consultant, Dr. Kenneth Brooks, Aquatic Environmental Sciences (AES), commented on the ITRC recommendations for the purpose of clarifying his proposed approach and reaching consensus on how to proceed with field studies and data collection. Dr. Brooks responded on 12/14/01 by inserting detailed comments within the 11/01/01 ITRC Recommendation memo, and submitting a 32-page document to Thurston County, Taylor Resources, and the ITRC.

The current document (dated 2/13/02) is the ITRC final response regarding the methods of study and information to be generated to address potential impacts to the aquatic environment for use in the State Environmental Policy Act (SEPA) EIS being prepared for the Taylor Resources project. This response is "final" in that there will not be additional debate concerning the Committee's recommendations. The request for additional scope of work information is reiterated in Sections B, C and D, below, to bridge the gaps between the PSI study and the site-specific mussel farm impact analysis, and to clarify inconsistencies between the original Scope of Work and Protocols documents (August–September 2001). The additional information will be subject to review and comment by the ITRC when it becomes available.

The discussion below does not continue the point-by-point debate, but rather summarizes major topics of discussion. Other topics or AES comments were not considered of major significance and/or were satisfactorily answered by the AES 12/14/01 replies.

A. Potential Impacts to the Benthic Community.

1) Choice of statistical models and pre-study sampling:

The ITRC agrees that regression analysis is attractive for defining the relationship between continuous variables in the proposed sampling in Totten Inlet, even if it has not been commonly used in the past. The Committee concurs with the selected design except for a few caveats noted below, none of which should prevent the sampling from occurring as soon as possible. However,

the Committee does not believe that regression is the only possible approach in all such cases, nor that collection of replicates at “single stations” is necessarily pseudoreplication in the present context. It is true that many regression models do not require single-station replication for the statistical test being proposed and given the circumstances discussed below, the Committee concurs with that part of the proposed protocols. The ITRC was more interested in the natural variability that occurs over small areas (i.e., 5 to 10 m), not the actual tests being applied. The ITRC notes that AES proposes to collect replicates at the reference station, which has not been explained in light of AES’s objection to collecting the same near the mussel raft locations. This inconsistency is discussed below in Item A.2), although both Items A.1) and A.2) overlap. Next, AES comments are discussed regarding replication at single stations and the possibility of replication should other inferential models such as *t* tests or Analysis of Variance (ANOVA) be used.

An important consideration for avoiding pseudoreplication depends on how one defines the experimental unit (observation) being measured, how the samples are collected at the “single station,” and several other considerations such as the overall size of the possible strike area actually being sampled by a grab sampler. The ITRC does not accept the analogy to side-by-side shallow or beach sampling in Oregon that AES refers to in the 12/14/01 discussion. Committee members agree that would be a case of pseudoreplication if done side-by-side, as stated. It is not comparable to grab sampling in much deeper water from a sampling vessel due to the much greater variability of location at which the grab sampler will actual strike the bottom. This could occur over tens of square meters given the statements about raft drift by AES, and other factors such as GPS accuracy. In any case, a simple test to determine the occurrence of pseudoreplication is that alpha (i.e., the significance level) increases while additional candidate replicate data are added to the test. If alpha is stable as candidate replicates are added, there is no problem (Hurlburt 1984). Such determinations can be made from pre-study data if necessary.

Setting that aside, leading benthic ecologists and consultants to the Washington Department of Ecology (Ecology) have concluded that collection of replicates at single stations in Puget Sound subtidal sampling does not constitute pseudoreplication. It is the opinion of Ecology’s primary consultants on these matters that **“individual samples are true replicates for a given location of interest”** in benthos sampling in Puget Sound (Washington Dept. of Ecology. 2000, page 13). One peer reviewer suggested that Ecology’s conclusions regarding benthic endpoints and the database were flawed because of the use of nearby replicates, but there is an apparent honest difference of opinion and the ITRC believes it is rooted in trying to be too general about specific issues. The Committee also believes it is a danger to get bogged down in this type of discussion at this point.

Even if pseudoreplication were to occur, the added samples would add to precision of the estimates for each station, which is desirable in the Committee’s view, and that of Hurlburt (1984, the key paper in this discussion). The replicates would not be used in the regression model in this case. The concern of the ITRC is that a single sample collected near the rafts or somewhere else along a transect or reference station would be taken from an unrepresentative location. This discussion should not get bogged down in the goal of satisfying statistical rigor, which is desirable, but not the goal of the work in itself.

An example of variability sometimes encountered is as follows. One member of the ITRC (J. Rensel) has made SCUBA observations of grab sample divots left at a number of sampling stations that were located on a transect perpendicular from a salmon farm in Puget Sound. In no case were the grabs within one meter of each other despite ideal sampling conditions of calm, sunny weather, slack tides and tightly anchored pen systems. The same observer has noted small-scale variation (patchiness) near several salmon net pens on the order of a few meters that involved changes from sand to silt and clay and small depressions and mounds that will obviously be influenced differently by an organic carbon input source. Now admittedly, this may not be the case in Totten Inlet. The upshot of this is that there are always site-specific conditions to be addressed, and the use of one-size fits all sampling designs are never appropriate, as also noted by an author cited by AES: Ferraro et al. (1989), who said:

“No single sampling scheme will be optimal in all locations, habitats, and for all study objectives. A universally applicable quantitative macrobenthic sampling scheme is an unattainable goal . . .”

This question can only be resolved by having advance information or pre-study results about an area. The ITRC suggested this in the 11/01/01 Recommendations memo. Apparently some pre-study information does exist (that the ITRC has not seen), and AES maintains it knows where the clines or strata are in the new raft study area. If that is so, then the sampling design can take that into account and the ITRC has no further comment at this time. The Committee does not request such proof at this time, but leaves it to AES’s best professional judgment that should involve some pre-study information as well as close review of the first set of sampling results, possibly even done in the field. The ITRC does, however, request that any data or final reports deal with these issues in the future. No further discussion of this topic is necessary at this time as most of the analysis relies on the regression model.

A final point regarding a pre-study is discussed here. AES has misstated in its 12/14/01 comments what the ITRC said in its original Recommendations memo dated 11/01/01. The ITRC was not referring to the examination of rare species or the method cited by AES above. Rather, the Committee was referring to species acquisition curve development, which simply shows how many samples are required to recover what percent of the species present. Please see Mahnken (1993) for an example of the use of species acquisition curves to determine what level of sampling is necessary to detect a certain degree of completeness. That degree of completeness need not include all “rare” species depending on the accuracy requirements of a particular survey. The ITRC does believe the method has value in planning an experiment, but does not insist on its use in the present project. The Committee did not say it was of any statistical use in determining the power of a test, and in fact statistical “power” is rather the probability that the test will correctly reject the null hypothesis when it is indeed false. The null hypothesis in regression is simply “is the slope of the line different from zero; i.e., is there a relationship in space?” The ITRC believes that common sense should prevail here along with statistical correctness, and that it is a concern to know if the sampling is detecting the moderately abundant species along with the common species.

2) Reference station comparison to treatment stations:

AES has proposed t testing to be done between reference and treatment stations, and notes that equal variances at each set of locations for sampling parameters will be assumed. Three replicates are proposed for collection at a reference station, but none at the treatment stations, unless there is to be some pooling of transect stations. The ITRC requests that data or final reports present information on how the replicate samples will be collected to prevent pseudoreplication. AES objected to collection of replicates near the raft locations, but has proposed their use at this other location, ostensibly because it is not part of the regression transect. The ITRC sees a possible inconsistency here, but understands that true replicates are necessary for the t test. If true replicates are to be collected, there should be some justification and plan for collection of these data to avoid pseudoreplication. As noted by Zar (1996), such testing relies on the assumption of underlying normality and equal variance between test and reference. Zar notes:

“The biological researcher cannot, however, always be assured that these assumptions (of normality and equal variance) are correct”. And later . . . “It is important to employ data that are true replicates of the variable to be tested.”

The ITRC also requests that if AES selects either a one-tailed or two-tailed t test, they discuss the differences in future reports and why one was selected. If replication is conducted, it need not be at all stations in the regression transect or any, depending on how it is presented. The ITRC notes that other tests including non-parametric tests may be employed in this same regard, although the Committee prefers the parametric tests.

3) Use of surrogate measures rather than infauna analysis:

The ITRC maintains its position that surrogate measures of infauna analysis are desirable if technically possible, but the Committee is not convinced that the state of the art is as advanced or failsafe as suggested by AES. Cost efficiency is important in survey design, but it is not the only controlling factor when the use of public lands and waters is involved. ITRC members have not critically reviewed Brooks 2001a (the British Columbia study of several salmon net pen sites), but note that most researchers, including Ferraro et al. (1989, cited by AES) insist that site-specific factors must always be considered in design of sampling programs. All members of the ITRC note that Brooks (2001a) is “gray” literature and has not been peer-reviewed. The Committee is not attempting to denigrate this extensive work product, but cannot completely judge its merits without reviewing it in detail (as we and others have not done so for publication), and note that it does not deal with Totten Inlet or with mussel farming impacts or any sites in Puget Sound. Accordingly, the Committee must take a conservative view of this matter.

The ITRC has a fiduciary responsibility to our clients (Thurston County and Taylor Resources) to note that we reserve the right to reject any future analysis based on this sampling scheme if local conditions appear not to be modeled appropriately by the surrogate indicators. We would prefer that infauna sampling occur throughout the term of the project, but note that if the surrogate indicator data is collected in the manner described, it may be indicative of the effects on the habitat. As no final infauna sampling will occur later in time, there is no way to

accurately judge that the surrogate indicators have done the job. This is not a black or white, either/or consideration, as surely the surrogate indicator data will be of some use in determining impact. If the initial surveys at the existing mussel farm site show the expected trends, and if the bottom at the proposed new site is suitable for the application of the proposed approach, the ITRC does not object to the use of selected surrogate indicators, noting again that there is considerable controversy about this subject and this is not a blanket endorsement of the approach or any future interpretation.

Without any other site-specific information, the ITRC does not consider it worthwhile to pursue this discussion further at this time. While AES may wish to respond in detail, note that our requests are modest and we suggest that no further discussion is required at this point.

B. Potential Impacts to the Surrounding Water Column.

1) Totten Inlet flushing time:

The Committee is generally satisfied with the AES 12/14/01 replies to the ITRC Recommendations memo (11/01/01) on the subject of analysis of potential impacts to the surrounding water column. As Dr. Brooks quite reasonably states, judgments cannot be made until preliminary results on carrying capacity and flushing time of Totten inlet are obtained. Indeed, if an attempt were made to design an experiment that would “once and for all” determine the flushing time of Totten Inlet, the design phase alone of such an experiment would require addressing several questions for which there currently are no answers, and for which something like the PSI study would be helpful. The necessarily incremental nature of the knowledge of flushing time in Totten Inlet cannot be overstressed. The ITRC encourages developing an estimate of flushing time as a range based on multiple considerations. A decision can then be made whether the degree of certainty is sufficient for decision making.

2) Totten Inlet carry capacity analysis:

The Committee is pleased that sensitivity analyses will be performed on the carrying capacity model; this will be very important. However, the AES comments also hint that the necessary analysis may not take place in the PSI study unless the second year’s funding is secured for that study. For this reason, it is important for a contingency plan to be developed now in case the PSI project fails to obtain this funding, and is not completed. It is very important that there be a clear line of communication between the PSI study and the AES study, so that the results needed for the carrying capacity study can be obtained. In the final report, the question of the carrying capacity of Totten Inlet should be addressed through a synthesis of the results from the PSI study and previous/other available studies of the Inlet.

C. Potential Impacts to Phytoplankton and Other Aquatic Life in Totten Inlet.

1) Additional scope of work document needed to “bridge the gap” between PSI study data and the North Totten Inlet mussel culture impact analysis:

Regardless of the choice of wording, as AES states – the PSI study is designed to assess “environmental issues affecting . . . farms,” rather than emphasizing how farms affect the environment, which is the point that was originally articulated in the 11/01/01 ITRC Recommendations memo. As stated before, much of the data from the PSI study can be used, but an additional scope of work document is still needed before any assessment of approach can occur. The additional scope of work document for methods to address potential impacts to phytoplankton and other aquatic life in Puget Sound should be provided in advance of the sampling season. It is not evident from the PSI proposal as it stands that sufficient information and appropriate techniques are included for a study designed to assess water and phytoplankton impacts from mussel farming.

2) Method for assessing mussel raft impacts using PSI study data:

It is agreed that a transitional document between the PSI study and the AES work is needed, but there must be more to this document than protocols. The Committee’s recommendations for the content of the transitional document are described in the 11/01/01 memo.

3) Use of historical water quality data:

The AES reference to Washington Department of Ecology “data quality assurance concerns” is unclear to ITRC members. ITRC Committee Recommendation C.3 (11/01/01) regards recent (late 1990s–2001) data. However, ITRC Recommendation C.3 asked for discussion of how all data (historical as well as new) will be treated in the impact analysis of the North Totten Inlet Mussel Culture Proposal.

4) Analysis of phytoplankton species:

The AES 12/41/01 comments do not address the 11/01/01 ITRC Recommendation C.4. The original C.4 recommendation should be incorporated in the transitional document requested in C.1.

5) Use of the SPASM model:

If modeling is to be a key element of the resources used to satisfy the requirements of the Taylor Resources North Totten Inlet Mussel Culture Proposal impact analysis, then details need to be outlined so evaluation can occur. Response to the 11/01/01 ITRC Recommendation C.5 is still needed.

D. Potential Impacts Associated with Escapement and Propagation of Mussels.

1) Survey of existing mussel populations in Totten Inlet and establishment of permanent study sites:

The AES 12/14/01 response regarding proposed methods for surveying existing mussel populations is acceptable and explains the sampling program adequately. However, the AES Scope of Services (8/29/01) and Protocols (9/01/01) documents still imply inconsistencies (as elucidated in the AES response). It would be useful for future reference if AES would develop a simple flow chart or table to show the definitive sampling plan proposed.

2) Differentiation of *Mytilus (edulis) galloprovincialis* from *Mytilus (edulis) trossolus*:

The AES 12/14/01 response is adequate in that the method suggested by the ITRC for mussel species differentiation is accepted, pending the availability of a laboratory to perform the analysis at a comparable cost.

References Not Previously Cited

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