Appendix 62
Qualitative Habitat Assessment (QHA): User's Guide

Qualitative Habitat Assessment (QHA) User's Guide
Version 1.0

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Brief Overview

The Qualitative Habitat Assessment tool (QHA) facilitates a structured ranking of stream reaches (or small watersheds) and aquatic habitat attributes for subbasin planning. QHA was developed primarily for resident salmonids though it may have applicability to other fish species as well.

QHA relies on the expert knowledge of subbasin planners to describe physical conditions in the target stream and to create an hypothesis about how the habitat would be used by a focal species. The hypothesis is the "lens" through which physical conditions in the stream are viewed. The hypothesis consists of weights that are assigned to life stages and attributes, as well as a description of how reaches are used by different life stages. These result in a composite weight that is applied to a physical habitat score in each reach. This score is the difference between a rating of physical habitat in a reach under the current condition and the condition of the reach for the attribute in a reference condition.

The ultimate result is an indication of the relative restoration and protection value for each reach and habitat attribute. QHA also provides a means to compare restoration and protection ratings to other biological and demographic information of the user's choosing. QHA includes features for documenting the decision process and describing the level of confidence that users have in the various ratings.

Note to Readers

Among the computer literate there are two types of people – those who read user's guides and those who don't. The QHA is simple enough to use without consulting this user's guide – even for users who have only a passing understanding of the underlying Excel spreadsheet program. However, while the technology is straightforward, we like to think that there are important considerations relating to the planning and biological aspects of QHA that make it worth consulting the user's guide. Besides, we stayed up several nights writing this. You can take a half hour to read it!

Introduction

Concept. While we considered hiring a high powered Madison Avenue marketing firm to come up with a name for this product, we instead used the first name that came to mind. The original name was Structured Qualitative Assessment Technique. Fortunate for us an astute colleague quickly recognized that the acronym gave the wrong impression. Hence, Qualitative Habitat Assessment, or QHA. While we could have contrived a more sophisticated name, we believe this moniker conveys the right message. This is, after all, just simple qualitative technique for assessing aquatic habitat using the professional judgment (or, if you prefer, expert opinion) of biologists and natural scientists who are familiar with a local watershed.

Applications. The QHA technique was developed as a means to characterize the relationship between a fish population and its aquatic habitat. It was developed principally for resident salmonids, though it could potentially be adapted for use with other species. The QHA is intended for use in stream environments at subbasin and provincial scales. QHA would not be particularly useful for assessment covering only a few stream reaches or small (i.e., 6^{th} field HUC) watersheds. The minimum number of reaches or small watersheds where QHA results would be meaningful is, perhaps, 20-25. There is no upper limit to the number of reaches or small watersheds but 300-400 would be a reasonable upper limit.

While it is possible to integrate lake or reservoir assessment findings with QHA, as currently constructed this technique would be of limited use for areas where a lake or reservoir is the dominant fish habitat. QHA could, however, be used to support a lake assessment by characterizing fish/habitat relationships in lake tributaries.

QHA would be particularly useful in subbasins where there is local knowledge of habitat conditions but where physical and hydrological data may be limited or localized.

Background on Qualitative Biological Assessment. Use of professional judgment is often criticized for being subjective and lacking consistency. On the other hand, it is well recognized that a strictly quantitative approach may not always be possible, or even preferred. For example, using a quantitative approach may not make sense in areas where data are limited, when there is not enough time allotted to conduct a rigorous quantitative assessment, or where appropriate tools or expertise are not available. In these situations a more qualitative approach is indicated. The 2000 *Template for Subbasin Assessment*, for example, referenced the use of "opinions of local fish managers" as an analytical tool.

The QHA was designed to minimize problems associated with unstructured qualitative assessments. QHA is what we call a "structured qualitative assessment." In other words, it is a systematic assessment of species habitat relationships that relies principally on existing local professional knowledge and judgment but that "structures" the process by: (1) following a logical and replicable sequence, (2) using the best available quantitative data as the basis for decisions, (3) generating a product that is similar in form to products resulting from other more quantifiable approaches, and (4) documenting the decision process.

Products. QHA produces a series of tables that (1) describe the physical habitat, and (2) identify where restoration and/or protection activities may be the most productive. Taken as a whole, these tables offer a means to focus the attention of biologists and planners and track the decision process.

Relationship to Other Techniques. QHA relies on the same conceptual framework as the Ecosystem Diagnosis and Treatment (EDT) technique. There are, however, several significant differences. While each of the habitat characteristics used in QHA is also used in EDT, EDT considers many more habitat factors and links these more directly to measurable data. QHA, by contrast, relies on the judgment of knowledgeable professionals to draw these linkages.

EDT relies on a set of objective biological rules derived from the technical literature to establish the relationship between a species and its habitat. Again, QHA relies on professional judgment to make this connection. EDT uses a series of life history trajectories to model the movement of fish through its environment over several life stages and over the entire life history. QHA collapses life history into fewer stages. Importantly, QHA treats each stream reach or small watershed as an independent static unit whereas EDT evaluates the connectivity of reaches and the variation in conditions within a year. Again, QHA relies on the knowledge of experts to think through the life history dynamics.

EDT analysis can incorporate information on out-of-subbasin effects, i.e., survival outside of the natal subbasin including ocean survival as well as harvest. QHA does not consider conditions outside the subbasin..

Lastly, EDT produces a series of numerical products that estimate productivity, abundance, and related factors that give an indication of how well habitat supports fish. As a qualitative technique QHA does not generate these outputs but rather produces an index of habitat condition and a series of products that suggest directions for management.

Using the QHA

Essential Materials. The QHA package consists of three computer files. The first is the user's manual (word file – QHA user's guide). You are reading it so presumably you have access to this file. The second is the actual product that you will use to conduct the analysis (Excel file – QHA shell). The third is a sample of the QHA, using the mythical Sheep Dip Creek Watershed (Excel file – QHA sample).

Getting Started. The technique makes use of the Microsoft Excel spreadsheet program. Essentially, the user opens Excel and loads the QHA shell, changes the name of the file to reflect the name of your subbasin (example: QHA Flathead), and proceeds to move through a series of sheets (or tabs) shown on the bottom of the computer screen. The first time user will definitely want to move through the tabs in sequence from left to right. The majority of the work in inputting information will be in the reference, current, and hypothesis tabs. Interpretation of results occurs in the restoration rankings, protection rankings, and tornado tabs. Restoration, protection, and tornado products are generated using information entered in the reference, current, and hypothesis tabs. The sheets are protected so that change is restricted to the input cells. If you get an error message about protection, that means you are trying to input data in a calculation cell.

Technical Support. Subbasin planners may, of course, use this tool as is. However, it will have to be customized to each subbasin to address the correct number of reaches or small watersheds. This will require some work to make sure that all cells reflect the changes and that the sheet is calculating scores correctly. There may be other modification necessary to meet the needs of the individual province or subbasin. With this in mind, the Power and Conservation Council will attempt to make available some amount of technical support through its subbasin planning technical support contracts, especially for initial set-up. Generally this support would take the form of (1) assistance in establishing a list of reaches or small watershed, (2) assistance in adapting the product to the local situation, and/or (3) training in the use of the product.

Modifications. Users who have experience with Excel programming may feel compelled to modify or expand the technique to meet the unique needs of a given province or subbasin. The developers of the product encourage users to think of ways that the QHA might be improved. As a courtesy, and as a means to maintain consistency among provinces and subbasins, it is requested that, prior to making significant modifications, you contact the developers of the product to apprise us of what you intend to do. This will allow us to keep abreast of how the product is being used and keep track of potential enhancements to the product. Besides, we may be able to help with the modifications.

Following is a description of each tab, working from left to right.

Setup Tab

This sheet provides a means for subbasin planners to input essential background information on the drainage being assessed, the focal species being considered, and the people contributing to the assessment. It also provides a brief summary of the method. It is important to identify a focal species at this point as this species will be the focus of the assessment. (Later we discuss how to deal with situations where there are more than one focal species.)

Reference Conditions and Current Conditions Tabs

Summary. The "reference" and "current" tables are the heart of the assessment. Using these tables subbasin planners characterize the physical condition of the subbasin. This is accomplished by supplying information concerning a range of habitat characteristics, with information arrayed by reach or small watershed.

Definition of Reference. In the "reference" conditions table we describe a "normative" condition for this subbasin that is used to contrast the current condition. This allow us to define "degradation " or "restoration".. In a subbasin with little cultural modification this reference condition might equate to "historic" conditions, that is, the conditions that were in place at the time of European settlement. By contrast, in a largely urbanized subbasin, say, the lower Willamette in Portland, this might mean accepting the urban fabric but taking aggressive action to restore habitat within the confines of this urban fabric.

Definition of Current. In the "current" conditions table we rate the condition of the aquatic environment as it is today. The one conceivable wrinkle is a situation where significant habitat enhancement (or degradation) is currently underway that will significantly change habitat quality within a defined timeframe. In these cases planners may decide to characterize current conditions as if these changes were complete.

Habitat Characteristics. In both the reference and current condition tables we look at 11 habitat characteristics, or attributes. These are:

Riparian condition
Channel form
Channel complexity
Stream unit types
Fine sediment
High flow
Low flow
Oxygen
High temperature
Pollutants
Artificial obstructions

For definitions see the "definitions" tab.

These are the habitat characteristics (or attributes) that are generally thought to be the main "drivers" of fish production and sustainability. There may, of course, be unique situations where planners believe that other attributes may be equally or more important. While, for purposes of consistency we encourage planners to retain the existing list of attributes, it is possible to substitute attributes or expand the definition of an attribute to encompass a more expansive concept. If this is the case, planners should clearly identify the change and document why this change was made. Theoretically it would also be possible to add factors. We have elected not to offer this option as it would have implications for the Excel algorithms. While someone with skills in spreadsheet design could, of course, make any changes that they may desire, for the sake of consistency and comparability, we ask that you refrain from changing or adding habitat characteristics unless absolutely necessary, and then only after contacting product developers..

Defining Reaches or Small Watersheds. Here we define a series of "reaches" or "small watersheds" that collectively make up the subbasin. Subbasin planners make the decision regarding how finely the environment should be divided in order to describe the stream and its use by the focal species. Planners should decide whether to use reaches or small watersheds and how these will be defined. A reach (or segment) is a linear stretch of stream whose upper and lower limits are defined by hydrological or ecological characteristics. A small watershed is a polygonal unit that includes several reaches that drain to the same point. The USGS/EPA hydrologic unit system available in GIS format at http://nppc.bpa.gov provides the basis for developing both reach and watershed definitions.

Reaches may be hydrologically defined, as is the case in the USGS/EPA river reach system where a reach is defined as the area between confluences. The 1:100,000-scale river reach system is the best example. Using this scale a subbasin will typically have between 1,000 and 3,000 reaches depending on size. This is probably beyond the scope of this project and in many cases planners will seek to define larger reaches that would bring the total number down to, say, 60 for the smallest subbasin and 300 for the largest. (This is the number of reaches that the developers of this system consider to be most appropriate for this type of assessment. We base this on (1) the accuracy that is possible through a qualitative assessment, and (2) the amount of time that it will take to fill in the table.) The alternative to a purely hydrological reach definition is a system based on ecological character, whereby subbasin planners manually review the streams in the subbasin and divide them into meaningful ecologically-consistent segments. The number of reaches will depend on the level of resolution. Planners could “lump“ or “split” to arrive at a number of reaches that is scientifically defensible and realistic in terms of workload.

The alternative to the reach is the small watershed. For the purposes at hand the developers suggest that planners wishing to use small watersheds consider using the 6th field hydrologic unit code (6th field HUC). This is available through http://nppc.bpa.gov. This is the finest scale that has been defined in a systematic level and results in a number of units per subbasin that should be manageable (typically 60 to 300, with an average of 100). Note that 7th and 8th field HUCs are used by some national forests but these have not been consistently defined across the Columbia Basin. A systematic Basin-wide layer of 4th field hucs is available but this is definitely too coarse for subbasin planning purposes. No systematic, region-wide 5th field HUC layer exists. The US Forest Service/Bureau of Land Management ICBEMP project did make significant use of 5th field HUCs (as well as 6th field). Planners who wish to use 5th field HUCs should consult www.icbemp.gov. Again, our recommendation is that planners wishing to use a small watershed approach first consider the 6th field HUC.

Regardless of whether planners elect to use reaches or small watersheds, these should be arrayed on the table in hydrologic sequence. In larger subbasins, planners may find it useful to group these into major drainages and assign assessment responsibilities accordingly. For example, a system such as the John Day, Salmon, or Flathead could be divided into four or five distinct units – lower mainstem, north fork, south fork, middle fork, etc. This will prove useful later when planners want to look at habitat characteristics for a specific fish population.

A Brief Overview of QHA Calculations. QHA provides a score that is an index of the physical conditions in a stream at a reach level (noting above that reach in this case could be a watershed like a HUC 6). The score provides planners with a structured way to compare the value of reaches and attributes for a focal species and identify priorities for protection and restoration. The score is based on a very simple algorithm:

Score = Physical Habitat Score * Life Stage Weight.

The Physical Habitat Score is the difference between the current conditions in each reach and reference conditions that describe the stream in a fully restored and a fully degraded condition (more on this later). The Life Stage Weight is assigned by the planners to reflect an hypothesis regarding how the focal species uses the stream. An overall Score is computed for a reach and for each attribute in a reach to allow you to compare restoration and protection priorities and identify key attributes.

Physical Habitat Score. The reference and current condition tables consider the relative value of the physical environment to fish productivity and sustainability by viewing each of the 11 habitat factors through the eyes of the focal species that inhabit the area. (This is important so please re-read the preceding sentence.) The cell that forms the intersection between a reach/small watershed and a habitat characteristic is rated according to the following rating scheme:

0 = ≥20% of optimum
1 = 20% to 40% of optimum
2 = 40% to 60% of optimum
3 = 60% to 80% of optimum
4 = 80% to 100% of optimum

There is no magic in the above rating scheme. The numerical scores are only included to give planners an idea of relative value. There is, obviously, little or no difference between, say, 39% of optimum and 41% of optimum. Our intent here is to have enough categories that knowledgeable professionals can discriminate between values but not so many that it would exceed what is considered realistic in a qualitative assessment. Planners have the option of using whole numbers (0 through 4) or decimal places if they wish to discriminate more finely, e.g., 3.50 or 3.75. The only rule is that they be consistent. (The algorithm is set up to handle two decimal places.) Using whole numbers is the simplest approach and may save some time, but we have been around too many fish biologists to not make allowances for finer numerical discrimination!

For the algorithm to work each and every cell must be rated. If you leave a cell blank it will automatically receive a rating of zero, which, as described above, translates to ≥20% of optimum. If you absolutely do not know give a rating based on what you would suspect it to be and give a low confidence rating. (Confidence ratings will be described later.). One way to address areas where you have little information is to extrapolate a rating using another similar watershed where you have a higher level of confidence.

Filling in these forms is the most time consuming element of the QHA. You will want to carefully consider how best to accomplish this. We assume that the forms will be completed by a group of local experts, either collectively through a delphi approach, or individually, with, say, three or four individuals (or sub-groups) each taking responsibility for a portion of the subbasin. (If done individually allowance should be made for peer review. Even with the full group approach this is still a good idea.)

Planners will need to decide whether it makes sense to start with current or reference. We believe that it probably makes sense to start with the reference condition, that is, depict what the aquatic habitat would be like historically or if fully restored. Regardless, the idea is to fill out one table and then use it as a template for the other. For example, if the reference conditions table is completed first, planners could then ask: “How have conditions changed as the result of human modification? Planners could then zero in on habitat characteristics that have changed and “adjust” the table rankings accordingly to create the current conditions reference table.

Planners will also need to decide whether to look at all characteristics in a given reach/small watershed (rows) or look at multiple reaches/small watersheds for an individual habitat characteristic. You will note that we set the default value on the reference table to 4, which represents ideal conditions for the species. We did this to give a frame of reference for your decisions and to simplify data entry. You can delete the initial rating if you prefer to start with a blank slate.

Confidence Levels. Below the list of habitat characteristics on both the reference and current conditions tables is a row entitled "attribute confidence." In this row subbasin planners have the option of rating the level of confidence that those filing in the table have in their knowledge of each habitat characteristic in this subbasin. The rating scale is as follows:

0 = unknown
1 = speculative
2 = expert opinion
3 = well documented

Similarly, at the right side of the table is a column labeled "reach confidence." This provides planners with the option of identifying the confidence that the planners have in their knowledge of individual reaches (or small watersheds). The same rating scale is used. Use of these confidence levels is optional and they do not affect computations. They do reappear later in the tornado diagram but only as information.

While confidence ratings do not figure into habitat rating calculations, we strongly advise using the confidence ratings as this will help to document the decision process and, ultimately, give an indication concerning how confident planners are in the final ratings. While it would be possible to fill in the confidence ratings for only some reaches or some habitat characteristics, we strongly urge you to give confidence ratings for all habitat characteristics and all reaches or small watersheds. This need not be a burdensome task. It may, for example, be possible to fill in confidence ratings for "blocks" of similar reaches at one time.

By filling in the row and column confidence ratings it is possible to ascribe a confidence level for any given cell in the table. In fact, this is what the spreadsheet does (though you cannot see it.) Essentially, what happens is as follows:

(1) For each cell a rating is given that is the sum of the row and column confidence ratings, i.e., a number between 0 and 6.
(2) This is then divide by 6 to give a number between 0 and 1.
(3) The ratings in each row are added up to give a number between 0 and 10.
(4) The row sum number is then divided by 11 (the number of attributes). The final confidence rating is a number between 0 (no confidence) to 1 (absolute certainty).

If you go to the tornado tab you will see a "restoration confidence" and a "protection confidence" rating for each reach/small watershed. These numbers were derived using the above formula. If you go to the confidence score tab you will see tables that present all confidence ratings.

Documentation. The reference and current conditions tables offer the opportunity to identify source materials or make comments. Planners may avail themselves of documentation for a given reach/small watershed (row) or for a given habitat characteristic (column). You will notice that we do not provide an option to provide documentation for an individual cell. We felt this would be excessive for a methodology of this type. While a compromise, we concluded that the row and column approach made the most sense.

Documentation does not influence any ratings so there is no absolute requirement that planners avail themselves of this feature. There is no requirement that each row and column documentation cell be filled. Planners should make their own decisions regarding how to best use the documentation feature. However, we believe that faithful use of the documentation feature will pay significant dividends, both in structuring the decision process and defending the resultant products. At the very least, use of the documentation feature will create a bibliography that can be inserted into subbasin plan documents.

For bibliographic references related to a given habitat characteristic and where the reference applies to multiple reaches -- for example a water quality report applicable to the whole subbasin -- it would probably be most efficient to cite this source once at the bottom of the appropriate column. For the water quality example the "pollution" column would be the appropriate place rather than recording this source for every reach or small watershed. Conversely, for a report that covers a wide range of attributes for a localized area the logical place to provide documentation would be at the end of the appropriate reach row.

Hypothesis Tab

Summary. This tab allows planners to use their knowledge of fish biology and the local subbasin to define a "hypothesis" concerning how the focal species uses the stream habitat. This creates a set of weights that are attached to the score for each Reach X Attribute cell to compute the final score. In other words, the hypothesis is the pair of "glasses" through which we will judge the scores for each reach and attribute. By clicking the "hypothesis" tab you see two tables. The first provides subbasin planners with the opportunity to apply their understanding of biological systems to make decisions regarding (1) the relative importance of each life stage to fish productivity and sustainability and (2) for each life stage, the relative importance of each habitat characteristic.

Life Stage Weight. First look at the table at the top of the screen. Using this table, the first order of business is to rate the life stages according to overall importance in the subbasin. Importance in this case really implies biologically limiting. In other words, the life stages are ranked according to their potential for limiting the population's persistence and abundance. This might be because fish spend the longest period in this stage (juvenile rearing, for example) or because the life stage is particularly susceptible to habitat conditions (spawning, for example). Remember that the ranking will result in a weight that is applied to the Physical Habitat Rating. Judge "importance" accordingly.

While there are several ways to delineate life stages, we have opted for the most simple – spawning, rearing, and migration. (Migration also includes adult.) Planners should rate life stages using a 3 to 1 scale, with 3 being most important. You may rate all three differently (1, 2, 3) or give two or all 3 equal weight. Giving two a weight of 1 and the third a weight of 3 would indicate that one is significantly more important than the others. The reason for doing this is to define the life stage that will be used to evaluate the importance of the various habitat characteristics.

The second task is to rate each habitat characteristic for each life stage. The scale is as follows:

0 = no effect
1 = does effect
2= critical effect

By rating both life stages and habitat characteristics you are establishing a simple hypothesis concerning how a given species interacts with its environment in this subbasin. The QHA applies the hypothesis to the information you have developed in the reference and current condition tables to develop a series of products. (We will get to the products later.)

The sample QHA presents one typical hypothesis where spawning is weighted highest (because of the sensitivity of spawning success to fine sediment, amount of suitable gravel, upwelling, winter temperatures and so on), and certain factors (e.g., sediment) are given a proportionally higher importance for the spawning life stage. The simplest hypothesis would be to rate all life stages equally (any number from 1 to 3 would work but for sake of this discussion use 1) and assume that all habitat characteristics made the same contribution to the species (i.e., give all habitat characteristics a 1 for all three life stages). In this case where all life stages and habitat characteristics receive a score of 1, there is no species weighting of habitat attributes and the score is simply the difference between the reference and current conditions.

In practice, it may be useful to consider more than one hypothesis, for example all 1s as described immediately above and one or more hypotheses where you use differential weightings that reflect your conclusions concerning how the biological system operates. You could then generate a set of products using both hypotheses and compare findings. This "multiple hypotheses" concept would be particularly useful in a situation where there is a difference of opinion among participants concerning how life stages and habitat characteristics should be weighted. There is no reason why these multiple hypotheses could not be run given that they are relatively simple to construct and all would make use of the same reference and current condition tables. Ultimately, of course, the objective should be to agree on one hypothesis. If this is not possible the only option would be to report both (or all) findings and describe why this was necessary.

Distribution. The lower graphic under the hypothesis tab arrays life stage distribution by reach/small watershed. You will note that two conditions are identified – reference and current. For each there are four categories – range, spawning, rearing, and migration. Range refers to the overall range of the species within the study area, including spawning areas, rearing areas, and migration or adult habitat areas. All other life stages must be embraced within this range. The other three are subsets of range. These may overlap between life stages. For example, a given reach/small watershed may be used for both spawning and rearing. In this case, the largest life stage X attribute weight assigned above will be used. The idea is to tag those reaches/small watersheds where the fish are present during any life stage.

For the current condition biologists will use their knowledge of the subbasin. In many cases there are GIS data layers available to help with this. See www.streamnet.org or contact the river information system people in your state's fish and wildlife agency. For the reference condition you will obviously need to extrapolate from your understanding of what conditions are required by fish at a given life stage and what conditions would be like if the subbasin were fully restored or, if you prefer, the historical distribution of the species within the study area.

In most cases the current distribution will be the same as – or a subset of – the reference conditions. An exception might be where a natural barrier has been removed increasing the current range over the historical. In a subbasin with little disturbance the reference and current distribution may be close to the same. In a disturbed subbasin there may be areas not currently inhabited by the focal species but where the focal species would return if habitat conditions were improved. This is, by the way, the case in the sample QHA, in that reaches 22-25 do not currently have fish but could if restored. Similarly, in an undisturbed area, reaches used for each life stage may be very similar to current conditions. In more developed areas spawning and rearing may have shifted or contracted.

Planners will need to determine what level of evidence is needed to define a reach as being used for any given life stage. This may range from documented observations to an extrapolation based on your knowledge of landform and habitat character. For purposes of QHA a more liberal interpretation is probably the best approach, as long as it can be defended. Obviously, consistency across the subbasin is important.

Please note that the distribution table and the life stage/habitat characteristics table interact. That is, in the computations, the ratings given in the life stage/habitat characteristics table are applied to reaches where a given life stage exists. For a hypothesis where all life stages and characteristics received the same weight (e.g., 1), this would have no effect. But if you had weighted one life stage higher than the others, and if a given reach/small watershed had all three life stages present, the life stage with the highest rating would drive the computation. In other words, if more than one life stage exists in a reach/small watershed, the analysis will focus on what you have determined to be the most important life stage.

Restoration Rankings Tab

This table provides a ranking of the final reach and attributes scores. Note that the scores themselves have no inherent meaning and, for this reason, the focus is on the relative ranking of the scores between reaches and between attributes. The highest rank is given a 1 (and highlighted in red), followed by 2 and so on. The table also identifies which reaches/small watersheds offer the highest restoration opportunity from a multiple habitat characteristic perspective (to the left of each row under the "reach score" column) and which habitat characteristics had the highest overall score (at the bottom of each column on the "attribute score" row). These scores adhere to the same 1, 2, 3 hierarchy.

This table was generated using information provided earlier in the current conditions table, the reference conditions table, and the hypothesis tables. The restoration table summarizes your physical and biological conclusions based on how you described the habitat and your hypothesis about the focal species. Planners should not accept this as absolutely correct or as the total answer. Rather, they should use it as a tool to provoke thought. Assuming planners are comfortable with the table, what does this suggest about limiting factors and potential restoration actions? Later in this guide we identify a list the questions that planners may want to consider when analyzing this table.

The Algorithm. The restoration rankings table is generated using the following algorithm.

$$\text{Restoration Attribute Score}_{ij} = (\text{Reference}_{ij} - \text{Current}_{ij}) * \text{LSWeight}_{ijk}$$

Where the Restoration Attribute Score is for reach *i* for attribute *j*, Reference is the attribute score for the reach and attribute from the Reference tab, and Current is the attribute score for the reach and attribute from the Current tab. LSWeight is the weight you assigned in the hypothesis table to the attribute (j) for the highest ranked life stage (k) using the reach (i). This equation results in a number that provides a relative indication of the effect of restoring conditions beyond the current condition. The reach score is the simple sum of the individual attribute scores.

Protection Rankings Tab

This table is the same as the restoration ranking table except that it identifies relative protection value rather than restoration value. The ranking is generated from an algorithm using information from the current conditions tables and the hypothesis tables. However, there is no explicit degradation reference condition identified and instead, QHA assumes that the degraded reference condition is the lowest rating for each attribute (0). In other words, the protection score is zero minus the current condition.

Planners will want to use this table as a jumping off point to consider areas that warrant protection, starting by asking whether the table is an accurate depiction of the real situation. If so, planners can proceed to identify major implications for management. Later in this guide we identify a list the questions that planners may want to consider when analyzing this table.

<u>The Algorithm</u>. The protection rankings table is generated from information in the current conditions tables and the hypothesis tables using the following algorithm.

$$\text{Protection Attribute Score}_{ij}. = (0 - \text{Current}_{ij}) * \text{LSWeight}_{ijk}$$

This results in a negative number that indicates a potential loss to the focal species if conditions were degraded beyond the current condition.

Tornado Tab

Click on the tornado tab and you will see a summary chart that shows, for each reach or small watershed: (1) relative restoration ratings, (2) relative protection ratings, and (3) confidence ratings for each of these. We call this a tornado because it often looks like one. The purpose of this diagram is to allow planners to look at the system from a holistic perspective. The tornado diagram displays the reach scores for protection and restoration. These scores have no inherent meaning but do have relative value to compare protection and restoration values between reaches.

To the left and right of the tornado diagram are a series of numbers between zero and one that summarize the confidence that planners have in these depictions based on the confidence ratings described earlier. This is important in that it suggests the potential level of uncertainty that may be involved in undertaking restoration or protection activities in a given reach or small watershed. Similarly, it may suggest areas where future research is indicated. (As with everything else in the QHA, planners should do a reality check on these confidence ratings.)

The sample tornado diagram suggests that a given reach often has both restoration and protection value. This may seem counter-intuitive but it is surprising how often this is the case. In fact, this may be one of the most important lessons to learn from the assessment, that is, it makes little sense to spend precious resources restoring a given habitat variable if others are allowed to degrade. For example, a reach with a rating of 2 for an attribute lies midway between fully optimal (4) and fully degraded (0) and will have an Protection Score of -2 (0-2) and a Restoration Score of 2 (4-2). If the reach and attribute are ranked high by the hypothesis then it will have both a high protection and restoration value, indicating that current conditions are good enough to have value to the focal species but that there is also room for improvement.

Confidence Score Tab

This tab simply presents the confidence ratings for reference and current conditions tables. How these are calculated was described earlier. (See "confidence levels" in the reference and current conditions tabs section for a full explanation.)

Other Factors Tab

We are considering adding an additional "other factors" tab that would provide a means to add additional information related to reaches/small watersheds that planners believe may be important to the include in the decision process. These would be in a chart/table similar to the distribution graph/table but instead of range, spawning, rearing, migration the headings would be one or more of the following:

Population Units (in larger subbasins, delineations between populations of the same species)

Biological Significance (areas with strains of native fish that meet a specified standard for purity)

Viability (What is your assessment of the overall viability of the focal species in the current habitat?)

Exotics (presence/absence or, possibly, relative abundance)

Unique Habitats (critical spawning areas, special habitat features, critical migration corridors)

Research (areas where past or ongoing research has established a base of information that would be useful in long-term monitoring)

Land Management (private, mixed, public, special protections)

Other (a placeholder for planners to introduce other ideas meaningful to their area and their analysis)

If implemented, these columns of information would be juxtaposed next to the tornado diagram so that these factors could be considered in the context of potential restoration and protection. Please let us know if this feature would be useful and the attributes that you believe should be included.

Definitions Tab

This tab presents definitions for each of the habitat characteristics used in the QHA. It also presents a table that identifies the types of measurable data that could be useful in determining the condition of each habitat characteristic. This latter table is arranged by life stage. These definitions are similar to the environment-habitat relationships in EDT. Further information on their meaning can be found in EDT documentation.

Reference and Current Documentation Tabs

These two tabs serve as repositories for bibliographic references and comments generated while completing the reference and current conditions tables. Information presented here will aid in generating a bibliography for the assessment portion of the plan document.

Analysis – Using the QHA to Make Decisions

Perhaps the single most important thing to remember concerning the QHA is that it does <u>not</u> make assessment decisions. It simply organizes the thoughts of the various local experts and presents information that subbasin planners may find useful in making these decisions. This section identifies some of the questions that could be explored using the information generated through QHA and displayed on the restoration rankings table, the protection rankings table, and the tornado graph.

The first question that should be asked when one looks at the restoration and protection tables is: Does this make sense? In other words, do the tables capture the prevailing expert opinion concerning how this system operates and what actions may be needed to improve its operation? If there is a disconnect between prevailing expert opinion and what the tables seem to indicate, what is the reason for this? Were the reference and current conditions tables completed properly? Are there additional factors that influence the system that were not captured in the reference and current conditions tables? Might prevailing wisdom be in error? If changes in the reference or current conditions are needed planners should do this. But please, do so with caution. The objective here is to use information to make decisions, not tweak the data until you get a result that you like! This is also a good time to consider an alternative hypothesis. Earlier we suggested possibly establishing a "constant" hypothesis where all of the numbers on the hypothesis table are set to 1 in order to compare and contrast results with your more custom hypothesis. Are there differences between, say, a restoration rang table using one hypothesis rather than another?

Once planners feel comfortable with the various tables they may wish to use these as a departure point for considering any of a number of questions concerning the relationship of the focal species to its environment. Following are some of the questions that planners may wish to consider:

- Are there clusters of reaches/small watersheds in close proximity that exhibit similar characteristics and that should be considered as a group?

- Which reaches/small watersheds currently provide the best habitat conditions for this species?

- Which have habitat conditions that are not conducive for this species?

- Are there clusters of adjacent small watersheds/reaches where the same habitat attributes are in poor condition?

- Looking at the entire subbasin (or, for larger subbasins, at all of the reaches/small watersheds for a given fish population), which habitat attributes are typically in a condition that supports this species or population? If there are multiple populations which have the most supportive habitats?

- Again looking at the entire subbasin or at a population unit within the subbasin, which habitat attributes are typically in a condition that is not conducive for this species?

- For the subbasin as a whole (or population units) what appear to be the major limiting factors?

- Which of these limiting factors are the result of natural conditions and which are the result of human modifications?

- Are there assemblages of habitat characteristics in poor condition that are influenced by the same upland land uses?

- Similarly, are there clusters of adjacent small watersheds/reaches where several habitat characteristics are in degraded condition? What does this suggest concerning causes and potential cures?

- Are there combinations of factors that appear to be related and that might be treated collectively?

- Where are there clusters of adjacent small watersheds/reaches where habitat attributes are in good condition?

- Based on habitat quality and population strength, which cluster of small watersheds/reaches should be considered strongholds and could serve as core areas to build from?

- Where have migratory linkages between populations or sub-populations been disrupted? Which areas afford the best opportunities for re-establishing linkages?

- Which clusters of small watersheds/reaches offer the highest benefit from protection of existing habitat conditions? Of these, which are at greatest risk?

- Which clusters of small watersheds/reaches have the highest potential for restoration of habitat conditions?

- Are there isolated small watersheds/reaches in poor condition where restoration might have significant benefit?

- For those areas identified for restoration, which habitat attribute(s) should be the primary focus for restoration?

- Are there areas where both protection and restoration are particularly indicated and what does this suggest in terms of treatment?

- What is the status of the various areas where protection is indicated? Are some of these more vulnerable than others?

- Where do we have the highest confidence in our findings regarding restoration and protection? Where the least? Does this indicate the need for further research and, if so, what and where?

- Are there additional factors not covered in the QHA that should be considered and what are their implications? (See the discussion in the "other factors tab, above.)

Questions and Answers

In this section we try to answer some of the key questions that have been asked of us concerning QHA. There is some unavoidable redundancy with information supplied in other sections of the user's guide, though we tried to keep it to a minimum.

Can the reference and current conditions tables be used for multiple fish species?

The reference and current condition tables consider the condition of several habitat characteristics relative to a specific fish species. The transferability of this to one or more other species must be determined by biologists who are familiar with both the subbasin and the biological needs of the species in question. Where species are similar in their biological response, e.g., the various resident salmonids, biologists may decide that the products are, in fact transferable. Or, they may conclude that the biological response is similar but may need some revision. In this case the prudent (and efficient) approach would be to use the products for one species as a template for creating similar products for another species. A common example would be focus on a specific habitat characteristic, e.g., high temperature, where local biologists believe there may be differences between species.

When transferring to a different species care should also be given to reviewing the hypothesis, both the weighting given to the various life stages and habitat characteristics and the distribution of spawning and rearing.

Essentially, if planners conduct the QHA analysis for two species they would end up with two Excel files, say – QHA Flathead bull trout and QHA Flathead cutthroat. With a few simple manipulations it would be possible to create tornado diagrams for both species side by side and use this to consider if there are opportunities for restoration and/or protection actions that might benefit both species.

How do we deal with areas where we have little information?

Information gaps are an issue regardless of assessment technique. A technique based on expert opinion (as is the case with QHA) probably allows more flexibility for dealing with this issue than a purely quantitative approach that relies on measurable field sampling. One approach for dealing with this is to identify similar watersheds where there is a good base of information and assume that the target watershed has similar environmental characteristics and biological responses. If this is done it is important to make note of this in the comment fields. Planners will also want to give a confidence rating that reflects this. If there is no information and no similar watersheds (a highly unlikely scenario), planners may leave blank those rows in the table where this is the case. If this is the case please leave the entire row blank or the program will attempt to compute a score with only partial information and errors will result.

Can this technique be used with anadromous fish?

Earlier in this user's guide we summarized the differences between QHA and EDT. EDT was originally developed for anadromous fish and this continues to be its primary use. QHA, by contrast, was developed to assess resident salmonids. While there are undoubtedly situations where QHA could be helpful in assessing anadromous fish/habitat relationships, it is important to understand the limitations.

Unlike EDT, QHA does not follow a fish through its entire life history as it moves from its natal watershed to, in the case of anadromous species, the ocean and back. With QHA, following a life cycle trajectory is left up to knowledgeable experts who draw inferences from QHA restoration and protection ranking tables.

There are several scenarios where QHA could arguably be used to support an anadromous fish assessment. One would be to use QHA as an initial inquiry that would set the framework for future quantitative analyses. Another, applicable mainly to large subbasins, would be to use QHA as a means to gain and overview of the entire subbasin while targeting smaller watersheds where more rigorous quantitative assessment may be warranted. The trick here would be to produce qualitative and quantitative products that are compatible so that the subbasin could continue to be viewed from a comprehensive perspective. Yet another scenario would be a subbasin where limitations in both time and resource dictated that an expert opinion approach be employed.

Can QHA be used in subbasins with lakes and reservoirs? How about links to mainstem reaches?

As presently constituted, QHA is designed for use with streams and stream habitat characteristics. It does not contain a module for dealing with adfluvial populations once these enter a lake or reservoir. For small lakes perhaps the best strategy may be to simply treat them as a reach or watershed. The best strategy for dealing with large lakes or reservoirs may be to apply the QHA to streams and watersheds and then "couple" that product with an independent assessment of the lake or reservoir. These would be "knitted together" using professional judgment. The course of least resistance would be to consider large lakes and reservoirs in the same light as anadromous fish assessments consider mainstem and ocean conditions. That is, create an assumption (based on professional judgment and employing whatever empirical data may be available) regarding the amount of mortality that occurs in the lake environment and the probably causes, and integrate that into the thought process when developing protection and restoration scenarios. It is, of course, good practice to document any assumptions.

In some instances a subbasin may contain populations that migrate out of the natal subbasin into mainstem reaches. This is, of course, always the situation with anadromous fish but it also occurs with some resident fish. For example, adfluvial bull trout are known to migrate to the mainstem Snake or Columbia where they spend a significant amount of time before returning to spawning areas in subbasin tributaries. For purposes of QHA, adfluvial resident salmonids that utilize mainstem areas can be treated similar to fish that migrate between streams and lakes, that is, make an assumption concerning mainstem reach mortality. If QHA is used with anadromous salmonids planners may make their own assumptions or use those soon to be developed by an interagency team. Remember, however, that QHA does not link life stages or reaches as does EDT. This can be a significant limitation for species where migration between different habitats is significant or where connectivity of habitats over a life history is important.

While QHA currently does not specifically incorporate lakes or mainstem areas, it may be possible create a QHA module that does this. Essentially this would involve (1) identifying the habitat characteristics to be considered (these would probably be different from those used with stream reaches and could include such added considerations as predation and competition), (2) subdividing the lake or mainstem area into meaningful geographic units, and (3) rating reference and current conditions as described earlier. This would obviously have its limitations but for some applications it may be informative.

Will an assessment using QHA meet ISRP standards?
The ISRP has not, to our knowledge, endorsed any one assessment technique. However, QHA was designed with scientific review in mind. As we understand it, the ISRP is less concerned with the use of any specific model and more interested that the assessment use good science and a logical decision process. From our reading of existing ISRP subbasin reviews, we assume that the ISRP would prefer a purely quantitative approach. But, in reality, there are often practical limitations (time, resources, data availability, and the applicability of existing models, to name a few) that indicate the need for a more qualitative approach.

The QHA responds to two of the major criticisms of qualitative assessment approaches in that: (1) it channels expert judgment into a logical and sequential thought process, and (2) it provides a means to track and document decisions. In addition, just because this is labeled a qualitative approach does not mean that it ignores quantitative information. Quite the contrary, planners who use QHA are urged to base their assessments on measurable data wherever and whenever these exist.

It is also important to remember that, regardless of the analytical tool selected, professional judgment will play a part in all assessments, no matter how quantitative, in that results will need to be interpreted. Like other assessment techniques, both quantitative and qualitative, QHA simply structures the decision process, it does <u>not</u> make the decisions. That is left to subbasin planners based on their best judgment.

If decisions are reasonable, if it can be demonstrated that the decision process followed a logical process, and if planners make use of the best available data and scientific knowledge, the chances of meeting scientific standards are, we suspect, good. In the end, the quality of the conclusions of a planning process will reflect the quality of the thinking that went into it, the documentation of that thinking, and a recognition of the limitations of the assessment. A flawed application of a quantitative model will not meet scientific standards, while a rigorous (and replicable) application of a more qualitative approach arguably will, especially if there is wide agreement among scientists and managers concerning the validity of findings.

Other Important Questions

Please let us know if you have other questions that should be addressed in this Q&A section and we will add them to the next edition.

GIS Applications

<u>Introduction</u>. The list of reaches or small watersheds developed by subbasin planners is the backbone of the QHA, and is the common element between reference and current conditions tables, restoration and protection rankings tables, and the tornado diagram. To the extent that these can be electronically linked to a spatial dataset of either linear stream lines or polygonal small watersheds, QHA findings can be displayed on maps and linked with other spatial data.

While GIS mapping is possible with either reaches or small watersheds, small watershed have certain advantages. First, if planners use 6th field HUCs that can make use of a pre-defined geographically referenced datalayer, thus making transfer between spreadsheet and spatial data layer easier than a custom-created set of reaches. Also, from a strictly visual perspective, polygons often “pop out” more readily on a map that do reaches.

<u>GIS Uses in Analysis</u>. There are numerous ways that GIS technology might be combined with spreadsheet information to aid in the technical analysis of QHA findings. Perhaps its major use would be to assist planners to visualize potential connections between various areas within the subbasin. Identifying clusters of reaches or small watersheds with similar characteristics is one obvious example. Another would be to analyze issues related to connectivity.

Yet another use would be to “overlay” two or more factors or concepts. This could aid in identifying convergence of factors. (For example, what is the relationship between protection rankings and spawning habitat? This could be ascertained using the spreadsheet alone but the spatial perspective could add a richness not possible in a table.) This ability to overlay might also provide a means to link QHA findings with other spatial data. For example, a map of QHA-derived protection opportunities could be combined with a land ownership, land use, and/or population density map to give an indication of relative risk. Another possibility might be to overlay information from the current conditions table with an applicable spatial datalayer in order to validate findings. For example, QHA pollution ratings could potentially be compared to a geographically referenced water quality dataset.

Next Steps. We hope to work with our regional partners to create examples of how QHA can be combined with GIS. As subbasin planners develop products using QHA and GIS we ask that you share them so that others might benefit from your ideas and experiences.

Is GIS Necessary? We have included this discussion of GIS to give planners an indication of some of the possibilities. However, please remember that QHA is not in any way dependent on GIS. While it makes sense to consider the possibilities afforded by GIS, both for analysis and presentation, it is important to remember that QHA was designed to be a simple, straight-forward technique that can be applied with a minimum of technological sophistication.

A Final Note

If anything in this user's guide is unclear, or if you detect inaccuracies, please let us know so that we can rectify these shortcomings. Thank you.

For questions, comments, corrections, or technical support please contact qha@subbasins.org.

For criticisms, use the same email address but include a valid credit card number and expiration date. We promise to get back to you. But please be patient, Internet connections from Fiji are notoriously slow at this time of year.

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