

**RESPONSE TO SCIENTIFIC PEER REVIEW COMMENTS ON
THE DRAFT POLICY FOR MAINTAINING INSTREAM FLOWS
IN NORTHERN CALIFORNIA COASTAL STREAMS**

JUNE 2009

**STATE WATER RESOURCES CONTROL BOARD
DIVISION OF WATER RIGHTS
CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY**

Response to Scientific Peer Review Comments on the Draft Policy for Maintaining Instream Flows in Northern California Coastal Streams

The State Water Resources Control Board (State Water Board) submitted the Draft Policy for Maintaining Instream Flows in Northern California Coastal Streams (Draft Policy) to six independent scientific peer reviewers in December 2007. Table 1 lists the names and affiliations of the six peer reviewers.

Table 1. Independent Scientific Peer Reviewers

Reviewer Number	Name	Affiliation
1	Dr. Lawrence Band	Department of Geography University of North Carolina, Chapel Hill, North Carolina
2	Dr. Charles Burt	BioResource and Agricultural Engineering Department California Polytechnic State University, San Luis Obispo, California
3	Dr. Robert Gearheart	Environmental Engineering Humboldt State University, Arcata, California
4	Dr. Margaret Lang	Environmental Resources Engineering Humboldt State University, Arcata, California
5	Dr. Thomas McMahon	Department of Ecology, Fish and Wildlife Program Montana State University, Bozeman, Montana
6	Dr. Richard Woodward	Department of Agricultural Economics Texas A&M University, College Station, Texas

The peer reviewers were asked to determine whether the scientific portion of the proposed Draft Policy is based upon sound scientific knowledge, methods, and practices for each of the following issues:

1. Setting seasonal limits on diversion
2. Establishing minimum bypass flow requirements
3. Establishing maximum cumulative diversion requirements
4. Conducting site-specific studies
5. Assessing the cumulative effects of water diversions on instream flows
6. Minimizing the effects of onstream dams on fishery resources
7. Providing passage for fish migration and requiring screening of water diversion intakes, and
8. Application of criteria developed to protect anadromous fishery habitat flow needs to fish habitat, in general, within the policy area.

In addition to the specific issues presented above, reviewers were asked the following questions:

- a) In reading the staff technical reports and proposed implementation language, are there any additional scientific issues that are part of the scientific basis of the proposed rule not described above?
- b) Taken as a whole, is the scientific portion of the proposed rule based upon sound scientific knowledge, methods, and practices?

The peer review comment letters are available at the State Water Board's Instream Flows Policy website: http://www.waterrights.ca.gov/HTML/instreamflow_nccs.html

The State Water Board's staff summary of each reviewer comment is provided below in bold text. Comments are numbered first according to the reviewer number (1-6), then by the reviewer's section number, and then by comment number within the reviewer's section. For example, Comment 1.3.2 refers to Reviewer #1, the third section, second comment in this section. Each comment is followed by the staff response. Technical responses were prepared for the State Water Board by Stetson Engineers and R2 Resource Consultants.

Reviewer 1. Dr. Lawrence Band, Department of Geography, University of North Carolina, Review of the Scientific Basis for the Proposed “North Coast In-Stream Flow Policy”, February 13, 2008

Comment 1.0.1 Introduction, pg. 1

“Ideally, a more detailed analysis of flow records, channel conditions, sediment transport and biological activity would have provided a more complete scientific basis for developing the policy choices. The documents provided for review contain a set of references to the limited time and budget available for data collection and analysis, and present very limited field sampling at one specific time, with flow records drawn from different periods of time. Given these limitations, the approach adopted in the proposed policy, to provide more conservative restrictions on in-stream water use at the regional level, is a sound strategy”

Comment noted.

Comment 1.0.2 Introduction, pg. 2

“While this review addresses the scientific basis of the proposed restrictions on surface water use, there are a set of potential unintended consequences, such as increased use of groundwater, that are beyond the scope of this review but need to be considered as part of a full watershed framework. This framework should also consider increased demand for water due to changes in population and economic activity, and changes in runoff production of unimpaired flow regimes due to trends in land use and potential climate change.”

The potential unintended consequences of the Policy, including increased use of groundwater, are assessed in the Substitute Environmental Document (SED) Appendix D, Potential Indirect Impacts on Municipal, Industrial and Agricultural Water Use and Related Indirect Impacts on Other Environmental Resources. This assessment also considers potential increased demand for water due to changes in population and economic activity. It does not consider changes in runoff production of unimpaired flow regimes due to trends in land use and potential climate change as Staff does not consider these to be impacts of the Policy.

Comment 1.0.3 Introduction, pg. 2

“ . . . in the absence of additional information, the conservative approach taken is warranted, as adjustments to the policy may be justified by more detailed and local-scale information.”

The Policy provides for the possible development and implementation of an effectiveness monitoring program to evaluate the regional criteria and whether the criteria may need to be modified. The Policy also allows for site-specific studies to support requests for using instream flow criteria derived from detailed local scale information.

Comment 1.1.1 River reach and network framework, pg. 2

“Statistical analysis designed to predict fish passage flow level requirements for any reach needs to consider not just the probability of passage restrictions in the local reach, but the potential for

restrictions in the population of reaches downstream. Considerations of channel substrate conditions within a reach requires an analysis of protectiveness of flow conditions in all upstream sediment production sites (low order, or colluvial, reaches), including those above the level of salmon habitat.”

The amount of flow needed for passage relative to mean annual flow is known to decrease in the downstream direction in a channel network. Data demonstrating this are provided in Appendix E of the draft Task 3 report in Figure E-1. By conservatively scaling riffle passage flow needs using surrogate measures of channel size and associated habitat-flow relationships (i.e., drainage area and mean annual flow), most low flow-related passage restrictions, other than those associated with highly site-specific geologic controls or human interference (e.g., culverts), are inherently avoided throughout the network.

Comment 1.1.2 River reach and network framework, pgs. 2 & 3

“Another critical aspect to consider is the rate-of-change of discharge downstream through the stream and river network. ... Study resource limitations have been cited as a reason for not incorporating more detailed and quantitative considerations of sediment transport dynamics, but this may be an area that will require more attention as the NCISFP is implemented and managed.”

The Policy provides for the possible development and implementation of an effectiveness monitoring program to evaluate the regional criteria and whether the criteria may need to be modified. The effectiveness monitoring program may develop data through monitoring of stream geomorphologic processes, including sediment transport dynamics. These data may be used to provide more detailed and quantitative considerations of sediment transport dynamics in the evaluation of the regional criteria, particularly with respect to modifying the selected percent magnitude of the 1.5 yr flood criterion.

Comment 1.1.3 River reach and network framework, pg. 3

“A potentially controversial policy element is the extension of the flow diversion restrictions and regulations on impoundments into smaller channels above the limit of salmonid habitat. ... the majority of water flow, both base flow and storm flow, are generated in these small catchments. ... Therefore, extension of diversion regulations into the headwaters is an important element of this policy in terms of cumulative impact.”

Comment noted.

Comment 1.2.1 Minimum Bypass Flow, pg. 4

“Discharge per unit drainage area could decrease significantly downstream under the recommended MBF. This has the potential to increase sedimentation downstream when flow is maintained at the MBF, particularly of sand sized and finer grained material. ... Some additional analysis may make use of any existing suspended sediment information to see if this has the potential to have any significant impact on substrate conditions required for different salmonid life cycles.”

This comment appears to reflect concern with a phenomenon experienced downstream of large dams when stream flows are maintained for long periods at some artificial baseflow and channel maintenance flows are reduced severely. However, as proposed by the Policy, the minimum bypass flow is a minimum stream flow, not a steady stream flow. Once flows rise above the MBF, diversions could occur as long as the total rate of diversion of all diverters above any point of interest does not exceed the MCD. This allows stream flows to remain highly variable, which would facilitate channel maintenance. The Draft Policy includes procedures for evaluating whether the requested diversion rates of additional diverters in a watershed would cause the MCD to be exceeded.

Comment 1.2.2 Minimum Bypass Flow, pg. 5

“Considering the appearance of migrating fish in “waves” following increases in flow conditions, it would be useful if it is possible to quantify “passage” protectiveness as a function of both effective width above threshold depth, and the expected density of fish migration.”

The Policy focuses on protecting anadromous salmonids habitat conditions. The goal of the Policy is to ensure that passage does not limit fish production, and by providing passage this is ensured. Factoring in fish density would require expanding the analysis to include fish population and individual-based passage behavior modeling, which is beyond the scope, resources, and time available for developing the Policy.

Comment 1.3.1 Maximum Cumulative Diversion, pg. 5

“A more cautious approach may be to consider a cumulative volume limitation to this element of the policy, in addition to the rate limitation, until a more detailed analysis of cumulative sediment transport across the flow range is carried out, or more site specific information is generated for individual cases.”

The analysis and discussion in the Task 3 report shows that a cumulative volume threshold limitation cannot be linked practically to protectiveness. In addition, there does not appear to be such a cumulative sediment transport criterion or metric available in the literature that can be applied in the context of regional instream flow regulation. This comment nonetheless demonstrates the need to allow site-specific studies to more definitively identify flow needs for a given stream and reach where diversions are high. Detailed analysis of cumulative sediment transport is highly site specific and an intensive analysis to perform, requiring bedload transport modeling, a hydrologic record, grain size distribution information, and channel morphology data.

Comment 1.3.2 Maximum Cumulative Diversion, pg. 7

“The use of an index event (the 1.5 year flood) as a surrogate for the effects of cumulative sediment transport and geomorphic work over the full distribution of flow levels, is based on the concept of the effective discharge ... The frequency of this event varies widely depending on climate and watershed conditions, and the 1.5 year return period chosen here is done so in the absence of more detailed analysis. A more detailed analysis might be done to generate these flow levels as the policy is implemented, and the impact of using a surrogate flow rather than a full magnitude and frequency analysis by using reasonable bedload equations can be generated”

See response to comment 1.1.2.

Comment 1.4.1 Seasonal limits on diversion, pg. 8

“Temperature thresholds for salmon appear to drop into acceptable ranges in October based on streamflow records. However, little information is given regarding stream temperature patterns as a function of both time and flow conditions, which would be useful to evaluate the impacts of reduced flow in early to mid Autumn. If this information is not available at a set of the USGS or other gauging stations in the area, there are a set of streamflow temperature models that might provide useful information. Some consideration should be given to expected trends in these seasonal fluctuations due to both potential climate change, and to changes in riparian canopy cover with expected land use change or forest pathogens (e.g. Sudden Oak Death).”

Individual water right applicants could use temperature modeling as part of site-specific studies to support proposals to use site specific criteria for their application in lieu of the regional diversion season criterion.

Comment 1.4.2 Seasonal limits on diversion, pg. 8

“The MBF that is recommended is postulated to provide sufficient habitat protection for the earlier (October 1) diversion start date in terms of reach specific depth and width conditions for passage and spawning. However, . . . missing from the analysis is a consideration of the timing of sediment production as flow conditions start to increase in the October and November time frame. The . . . potential consequences of the Minimum Bypass Flow and the Maximum Cumulative Diversion elements in terms of sediment balance is particularly important during the initial increases in flow . . . “

Sediment balance is addressed by the MCD element of the Policy, which maintains natural flow variability, including during the months of October and November. Flows most affected during this period would likely be those transporting predominantly fine grained sediments; larger flows transporting coarse bedload would not be adversely affected. The Task 3 report projects that the primary consequence on sediment transport and channel form by using MCD2 is through a small reduction in channel size and grain size characteristics.

Comment 1.5 In-stream impoundments and fish screens, pg. 8

“The restrictions set for new and existing in-stream impoundments and diversion fish-screens appear to be reasonable, based on available understanding and information on migration barriers.”

Comment noted.

Comment 1.6 Monitoring, compliance, effectiveness, validation, pg. 9

“As recommended in the policy document, a significant increase in the stream gauging network is required, with real-time capability, likely co-funded with the USGS to take advantage of the National Water Information System (NWIS) real-time discharge system. . . . Monitoring and management of the finite water resource network calls for the development of a more advanced

sensor network to monitor stream temperature, turbidity, suspended sediment transport in addition to flow. The State of California should be in the position to develop and implement this type of network in collaboration with federal agencies and the university system.”

The Policy provides for the possible development and implementation of an effectiveness monitoring program to evaluate the regional criteria and whether the criteria may need to be modified. The effectiveness monitoring program may develop data through monitoring of stream hydrology and geomorphologic processes and salmonid habitat conditions, which presumably could include stream temperature, turbidity, and suspended sediment transport in addition to flow monitoring. The program provides for the possible coordination with other agencies responsible for similar monitoring.

Comment 1.7 Adaptive management, pg. 8

“The approach proposed in the NCISFP scientific basis documents is well considered, and requires active support and implementation... In addition to the distributed monitoring system, the State of California should consider implementing a distributed hydrologic model to estimate the cumulative impacts of development and water diversions in the set of watersheds of interest.”

Comment noted.

Comment 1.8.1 Summary, pg. 10

“The “precautionary principle” adapted within the proposed NCISFP is an important element as it places a priority on protecting threatened habitat that would be difficult to replace, while encouraging the collection of additional information and building the knowledge base to both reduce uncertainty at the regional level and provide more specific guidelines locally. “

Comment noted.

Comment 1.8.2 Summary, pg. 10

“One area to consider in terms of outcomes is the emphasis on passage and habitat conditions for spawning, incubation, rearing, and outmigration that appears to drive the MBF proposals. An implicit assumption is that sediment transport processes at these lower flow levels are not significant. However, even if the magnitude of transport is small and do not mobilize significant amounts of coarser grained material, impacts on fine grained transport and deposition should be considered as proportional reductions of flows increases downstream (by increased proportional diversion rates). Interactions with MCD and seasonal limits on diversions need to be considered as part of this framework”

The predicted impacts of reduction of flows on channel width, depth, and grain size distribution are shown in Figure 2-1 in the draft Task 3 report. The MCD limits the total rate of diversion of all diverters above each point of interest in a watershed to 5% of the 1.5 year unimpaired peak flow and thereby prevents proportional reduction of flows downstream and protects channel maintenance flows. Also see response to comment 1.4.2.

Comment 1.8.3 Summary, pg. 11

“ . . . [T]he policy framework is carefully thought out with acknowledgement of the current limits of predictability. The framework of adaptive management, if properly implemented and supported by comprehensive monitoring and analysis, should provide the ability to maintain protection of salmonid habitat, while allowing justifiable water resources development.”

Comment noted.

Staff thanks the reviewer for his comments.

Reviewer 2. Dr. Charles Burt, Ph.D. P.E., D.WRE., Registered Civil and Agricultural Engineer, Optimization of Water Delivery and On-Farm Irrigation/Drainage Systems, letter dated January 31, 2008

Comment 2.01 Irrigation-related Review, pg. 2

“The statement that ‘Frost protection occurs by spraying water over the plants to keep the air temperature around the crops from dropping below freezing’ is incorrect . . . Protection attributed to controlling the air temperature is fairly insignificant with this method of irrigation for frost protection.”

Comment Noted. Staff will consider making modifications to the supplemental memo to address this comment.

Comment 2.02 Irrigation-related Review, pg. 2

“ The supplement states that ‘ . . . recorded daily low temperature was 33 deg Fahrenheit or less. . . ‘ and ‘hourly temperature data were not readily available’. Sprinklers must be turned on well before the air temperature drops to 32 deg. F, because when they are turned on, the air temperature drops to the wet bulb temperature, which can be quite low if the air is relatively dry. Therefore, the only way to properly estimate the hours of operation is to know hourly data. Ten hours may be inadequate.”

Selection of the 10 hour frost event on 8 separate days (80 hours total) between March 15 and March 31 is a conservative way of estimating the demand needed for frost protection for use in a water availability analysis. The temperature data was used only to determine a reasonable number of frost days that may have occurred in the month of March. Using the recorded daily low of 33 degrees was a conservative way to estimate potential frost days since the recorded low never reached freezing. Estimating a ten hour frost event on every single frost day is also a conservative estimate of the demand for water for frost protection. Ten hours a day is probably an adequate estimate. Having conducted many compliance inspections within the Policy area and talking with growers during these inspections, it was the author’s experience that a frost event lasting 10 hours on a single day was a rare event. This was also the experience of staff working in the Division’s licensing program, who conducted licensing inspections of growers seeking a license of a permit authorizing frost protection.

Comment 2.03 Irrigation-related Review, pg. 2

“There are certainly huge variations in temperature and relative humidity throughout the region. Therefore, making tight policy (8 days, 10 hours) based on limited data does not appear wise.”

The draft policy does not require that the diverter only take water for frost protection for 10 hours over 8 days for an entire frost season. The assumptions were incorporated into the draft Policy as guidance for the applicant to use when estimating frost demand in a water availability analysis and determining if there is water available to supply the proposed project. As discussed above, these assumptions give an estimate of 80 hours of water demand for the time period of March 15 through March 31 and appear to be conservative. An estimate of the existing demand is needed to determine whether or not an adequate supply remains for a proposed project seeking a water right permit. The draft Policy sets the diversion season for new and pending water right applications to October 1 through March 31. It is recognized that the frost season typically extends until about May 15, however since new applicants can not

divert after March 31, an estimate of frost demand by existing authorized diverters is only needed for a short time period for the purposes of determining water availability for the new application.

Comment 2.04 Irrigation-related Review, pgs. 2& 3

“To make [the example of Permit 21006] transferable, one would need to know the details of the temperature how those compare to other areas, the size of the field, and the design flow rate (GPM/acre).

The use of Permit 21006 as an example helps validate the assumptions generated for frost protection. When a water right permit is issued, it authorizes a specific quantity of water to be diverted for specific uses. The permittee cannot divert more water than is authorized by the permit or they would be making an illegal diversion of water. Most permits are issued based on diversion rates and or amounts requested by the applicant and it is the responsibility of the applicant to request the amount of water they think they need for their specific uses. In the case of Permit 21006 the applicant should have taken into consideration the design flow rate of the sprinkler application, the size of the field, and the variable temperatures for the area before requesting an amount of water on their application.

Permit 21006 helps validate the assumptions generated for estimating frost demand because it authorizes diversion of water for frost protection from March 10 through March 31, the same time period considered necessary for evaluating the water demand for frost protection in the water availability analysis. Permit 21006 has a specific diversion quantity limitation of 120 acre-feet for this time period. Using the rate of diversion (21 cfs) authorized by Permit 21006 and the assumptions generated for frost demand, a comparison was made between the results of using the assumptions and the specific annual amount limitation listed on the permit. The results were favorable and therefore helped validate the assumptions. Some of the older permits and licenses do not have the annual amount limitation listed on Permit 21006. Therefore without site specific knowledge of each individual project, assumptions need to be made about demand when conducting a water availability analysis. This is the purpose of the assumptions regarding frost demand that are found in the draft Policy. They are in the draft Policy to provide guidance to the applicant when estimating the demand of all senior diverters within a watershed for the purposes of water availability and should only be used when better information is not known about a specific project.

Comment 2.05 Irrigation-related Review, pg. 3

“ ... it appears that the single statement of “Additionally, if better information is available for a particular project, it should be used” addresses the concerns. It is strongly recommended that the issue of frost protection be treated with a high degree of flexibility”

The issue of frost protection is treated with flexibility and conservatism with respect to existing authorized diverters. An applicant has the right to request as much water as they think may be necessary for their project. The main concerns are whether or not the quantity requested will have an impact on instream flows. The assumptions generated for use in the water availability analysis are conservative for the time period being evaluated. This conservatism protects the diverters with existing water rights because existing demands for the March 15 to March 31 time period may be less than what is estimated for the existing project. The assumptions are not

binding on the diverters' ability to take water and as previously stated are for the purpose of providing guidance to the applicant conducting a water availability analysis.

Comment 2.1.1 General Review, first major criticism, pgs. 3 & 4

“I was unable to grasp exactly what the simple impacts of implementing the Policy would be on existing diverters.”

Existing diverters include authorized diverters with existing permits or licenses, and unauthorized diverters who are diverting water without a basis of right. The flow related criteria in the Draft Policy impacts existing *authorized* diverters if a petition for change to an existing water right involves a reduction in flow in a stream reach. Existing *unauthorized* diverters must comply with the Policy in order to obtain a water right permit.

Comment 2.1.2 General Review, first major criticism, pgs. 3 & 4

“basic questions that were unanswered include:
a. How many diverters will be directly impacted?
b. To what degree will those diverters be impacted?
i. Time of year
ii. Flow rate
iii. Acre-feet of annual diversions
c. Where are those diverters located?”

The numbers of diverters with pending water right applications and potential future diverters are estimated in the SED Appendix D, Potential Indirect Impacts on Municipal, Industrial and Agricultural Water Use and Related Indirect Impacts on Other Environmental Resources.

The number of unauthorized onstream dams that will be impacted by the Policy is estimated in the SED Appendix E, Potential Indirect Environmental Impacts of Modification or Removal of Existing Unauthorized Dams.

Comment 2.1.3 General Review, first major criticism, pg. 4

“As a small detail, it would have helped to see a map showing the physical upstream limits of the proposed Policy on each stream.”

Section 3.2 of the Draft Policy contains Figure 1, which displays a map of the geographic area affected by the Policy. In addition, GIS layers are available on the State Water Board's webpage showing in detail the physical upstream limits of the proposed Policy for streams in the Policy Area.

Comment 2.2.1 General Review, second major criticism, pgs. 4 & 5

“I recommend that the Policy include the following program steps:
a. Defining of priorities and relative benefits for taking specific actions. ...

- b. Verification of the actions, as they are accomplished in order of priority.
- c. Documentation of the consequences of the actions. ...
- d. Re-evaluation of the types of actions that have been recommended, and their documented consequences/impacts.
- e. Development of modified recommendations, including how/when the next layer of priorities should be implemented.”

In complying with AB2121 the State Water Board must take in to consideration the practical aspects implementing the Policy in the context of water rights administration. The Policy, as written, can be practicably implemented. The steps described by the reviewer would be best considered in the development of an effectiveness monitoring program for evaluating the effectiveness of the adopted Policy’s regional criteria.

Comment 2.2.2 General Review, second major criticism, pg. 5

“In one background document... the following statement is made:

“Lifting Policy limitations above structural barriers would not be protective of the anadromous salmonid resource if the possibility exists that historically accessible habitat will be re-opened by correction of passage barriers.”

... mandating policy based on a vague “possibility” should be questioned. If all downstream passageways are cleared, and fish begin to appear at the upper end of those clearings, then clearly the possibility of salmonid expansion into the upstream areas exists. But until the downstream passageways are first cleared, one can certainly state that “the possibility does not exist that historically accessible habitat will be re-opened by correction of passage barriers.”

Water rights, once permitted, require a lengthy administrative process to modify or revoke. The Policy is based on a conservative assumption that barriers may be opened in the future and that new water diversions should not be permitted in case these instream flows will be needed in the future to provide protective anadromous salmonid habitat.

If evidence can be provided that a barrier can not be opened, the upper limit of anadromy and the site-specific instream flow requirements can be calculated according to the procedures in the Policy in Sections 4.1.4 and 4.1.8.

Comment 2.2.3.a General Review, second major criticism, pg. 6

“a. The [Task 3] report acknowledges scientific uncertainty ... However, the proposed Policy appears to attempt to obtain zero uncertainty regarding negative impacts on fish.”

The Policy does not attempt to obtain zero uncertainty regarding negative impacts on fish, rather, precisely because of uncertainty the Policy sets regionally protective criteria that conservatively protect fish throughout the Policy area. Because these criteria might overprotect on some streams, the Draft Policy also allows water right applicants to use criteria developed from site specific study.

Comment 2.2.3.b General Review, second major criticism, pg. 6

“b. The “Minimum Bypass Flows (MBF)” for MBF3 appear to assume a linear (zero intercept) relationship between area and unimpaired mean annual flow. ... why is the acceptable flow in one basin 2-5 times the acceptable flow in another basin with the same area?”

The MBF3 relationship does not assume a linear relationship with zero intercept between drainage area and mean annual flow. Because of the variety of factors influencing habitat availability with flow in addition to drainage area, one would expect different streams with the same drainage area to have different flow requirements for spawning. The variation indicated, 2-5 times, is not unusual and is a reason why the Policy also provides the option to conduct a site specific study that evaluates other factors. The relationship embodied in the MBF3 alternative reflects data and is consistent with general research findings discussed in the instream flow scientific literature.

Comment 2.2.3.c General Review, second major criticism, pg. 6

“c. The MBF for MBF4 is one tenth (10%) of the value for MBF3. How can science-based recommendations, intended to achieve the same objectives, be different by a factor of 10 times? ...the explanation of uncertainty is not clear. Therefore, the selection of the highest, most extreme value appears indefensible. No sensitivity analysis is provided. There is no basis for comparison... without such a sensitivity analysis, the conclusion that $Q_{MBF}=0.6Q_m$ can only be regarded as arbitrary rather than science based ... Why, then, was MBF4 not selected when it is sufficient (perhaps imperfect, but “sufficient”)?”

MBF3 and MBF4 do not achieve the same objectives and are based on different criteria, as described in Appendix E of the Task 3 report. The MBF4 flow is not protective of habitat and is an estimate of the threshold flow below which there is no habitat, whereas MBF3 is protective of habitat and provides favorable habitat conditions. In a given stream reach, these two flow levels can vary by a factor of 2 or 3, and can vary across streams by an order of magnitude.

As discussed in Appendix D of the Task 3 report, a regional Policy-implemented flow level cannot be regionally protective of anadromous salmonid habitat by definition if it does not protect habitat-providing flows in all streams. Since not all streams for a given size and hydrology require the same level of instream flow due to various factors, the actual flow required in some streams may be similar to the Policy level while the flow required in other may be lower. The only way to more precisely assess the required level of instream flow in a given stream is to conduct a site-specific study, which the Policy allows. The site-specific study results may indicate whether or not the instream flow criteria can indeed be lowered for the particular stream in question.

A sensitivity study (Stetson Engineers and R2 Resource Consultants, North Coast Instream Flow Policy, Water Diversion - Passage and Spawning Habitat Sensitivity Study, June 2009) was performed to evaluate alternative MBF regional criteria and the potential water diversion volume and number of days of spawning and passage opportunities associated with each alternative. Based on the results of that analysis, it was concluded that an MBF criterion based on a 0.7 ft steelhead minimum spawning depth criterion in the validation sites would be similarly protective as one based on a 0.8 ft criterion. However, the analysis results suggested that reducing the MBF criterion by

lowering the adjusted regression intercept coefficient below the recommended level of confidence (mean + 3 standard errors) would likely impact habitat in some streams. Therefore, it is now recommended that the MBF criterion be based on Equation MBF A8 of the sensitivity study report (an equation derived using the 0.7 ft steelhead minimum spawning depth criterion mean regression line plus 3 standard errors).

There are insufficient data available to determine instream flow needs for spawning, passage, and other habitat functions in large rivers, hence the default to $0.6Q_m$, a hydrologic based parameter. This criterion has been used in the past in other systems based on professional biological judgment and experience.

Comment 2.2.3.d General Review, second major criticism, pg. 7

“d. The formulas for “Minimum Bypass Flows (MBF)” appear to assume that at each node (bifurcation point) in a stream system, the QM (unimpaired mean annual flow) is known. ... The procedure for defining the QM at each node must be scientifically defensible and clearly defined.”

The procedure for estimating the mean annual unimpaired flow at the points of interest is clearly defined in Section A.5.2.1 of the Policy, page A1-14.

Comment 2.2.4 General Review, second major criticism, pg. 7

“Any Policy cannot eliminate risk. A goal to minimize risk, taking logical and sequential steps, is much more reasonable.”

See staff's responses to comments 2.2.2 and 2.2.3.a. By providing regionally protective criteria while allowing water right applicants to more accurately determine local fishery resource instream flow needs based on site-specific studies, the Policy inherently minimizes risk.

Comment 2.3.1.1 Documentation required for a new diversion permit, pg. 7

“The Substitute Environmental Document ... Table 3-1 provides cost estimates for permitting a diversion, but those costs do not appear to be in line with the description of the requirements.”

The costs provided in the Direct Cost Analysis for the Proposed Policy Table 3-1 were estimated based on Stetson Engineers' and R2 Resource Consultants' professional judgment and experience supplemented by Division staff estimates of the costs for performing water availability analyses.

Staff points out that the costs provided in Table 3-1 are estimates, and actual costs may vary from application to application depending on several factors, as described in the report. An engineer who is familiar with the stream and watershed and who has a working knowledge of the databases used in the analysis, including the Divisions' WRIMS database and USGS streamflow database, should be able to complete the water availability analysis according to the Policy methodology in a cost effective manner.

Comment 2.3.1.2 Documentation required for a new diversion permit, pg. 7

“The true cost of a permit will likely eliminate any ordinary citizen from submitting an application – only municipalities and large companies could afford to provide such documentation. Perhaps this will not be an issue if the permit will only affect off-stream users, rather than riparian users.”

The Policy does not apply to riparian users. Costs associated with a permit are necessary to protect instream flows.

Comment 2.3.2 Documentation required for a new diversion permit, pg. 7

“On pages 8-12 of the Substitute Environmental Document, it appears that the permit requester will be responsible for accumulating many documents that should be available from the Regional Water Quality Control Board. Therefore, it is recommended that the RWQCB maintain excellent current GIS databases and provide pertinent documents, for a fee, to any person/entity that wishes to apply for a permit.”

The public may access the State Water Board’s water right files by appointment. The State Water Board also maintains a website containing information to assist water right applicants. The State Water Board will also continue to make available to the public the water right permit and license information that can be accessed from their Electronic Water Rights Information Management System (eWRIMS) via the internet.

Staff thanks the reviewer for his comments.

Reviewer 3. Dr. Robert Gearheart, Ph.D. P.E., Letter Dated February 4, 2008

Comment 3.1.1 Definition of Protectiveness, pg. 1

Maintenance of suitable temperatures should be included in bulleted list on pg. xviii

The executive summary of the Task 3 report will be modified as suggested. The importance of maintaining suitable temperatures is described in the report and indeed influenced development of the Policy.

Comment 3.1.2 Definition of Protectiveness, pg. 1

“While mention of water quality is referenced in several sections it seems that a continuity discussion of the impact of water quality constraints should be addressed. A question would be, 1) are there permitted NPDES discharges to consider in the reaches of concern and are there temperature and/or sediment/turbidity issue associated with various land uses. Does the policy consider permitted discharges as a component of the flow? The inclusion of these types (of flows NPDES) might be more critical (beneficial and/or detrimental) during periods of summer and early fall flows.”

NPDES discharges are regulated by the Regional Water Quality Control Board. The Regional Board may modify discharge requirements for NPDES discharges as hydrologic conditions change (for example, as a result of future diversions) as necessary to protect beneficial uses. NPDES dischargers that are proposing to modify place of use, purpose of use, or point of discharge are required to submit a wastewater change petition to the Division, and will need to demonstrate the extent, if any, to which fish and wildlife would be affected by the change, and a statement of any measures that would be taken for the protection of fish and wildlife in connection with the change; and the likelihood that the proposed change will not injure any other legal user of water.

Comment 3.1.3 Definition of Protectiveness, pg. 1

“There seems to be a potential interagency (California) void in terms of the involvement of other state agencies which impact the fisheries beneficial uses of the these rivers.” What are roles of Department of Water Resources, Regional Water Quality Control Board? “The success of the implementation of this policy is seriously constrained due to the possible agency voids.”

Appendix K of the Task 3 Report provides recommendations for an effectiveness monitoring program designed to assess the effectiveness of the adopted policy over the long term. The Appendix suggests the establishment of a Monitoring Oversight Committee consisting of State Water Board staff and staff from other state and federal agencies (including the Department of Water Resources, National Marine Fisheries Service, Department of Fish and Game) to develop and provide oversight of a coordinated monitoring plan to assess the benefits of the adopted policy.

Comment 3.1.3.1 Definition of Protectiveness, pg. 1

The role of groundwater abstraction on stream flows is important, also maybe issue of tail water, for consideration in the Policy.

The State Water Board has permitting authority over groundwater in subterranean streams flowing through known and definite channels. Water right applications for withdrawals from these subterranean streams will be subject to the Policy.

Percolating groundwater is not subject to the State Water Board's permitting authority and, hence, the Policy. However, the State Water Board may exercise its authority under the doctrines of reasonable use and the public trust to address diversions of surface water or groundwater that reduce instream flows in the Policy Area and thus adversely affect fish, wildlife, or other instream beneficial uses.

The potential indirect impacts of the Policy, including increased use of groundwater and effects on stream flows are assessed in the SED Appendix D, Potential Indirect Impacts on Municipal, Industrial and Agricultural Water Use and Related Indirect Impacts on Other Environmental Resources.

Comment 3.1.4 Definition of Protectiveness, pg. 1

“Figure 4-1 was a good starting point and should, in my opinion be presented early in the document to give the reader a road map of how the policy was developed. This figure also helps show why the gaps in the historic data required site-specific information.”

Section 4 of the Task 3 Report describes the analysis used to analyze for protectiveness of the Policy element alternative criteria. Figure 4-1 outlines the analysis steps taken, and is more appropriate for the discussion in Section 4, rather than being placed in the earlier sections of the report.

Comment 3.1.5 Definition of Protectiveness, pg. 1

“As the policy is developed in the document the science, while appropriate, needs further development and validation.”

Further development and validation of the Policy will be provided by site-specific studies and possibly through the implementation of the Policy effectiveness monitoring program.

Comment 3.1.6 Definition of Protectiveness, pg. 1

“My concern is there are conditions on the elbows of the season (especially in the later spring of a dry winter) and the low flow conditions in the summer that appear to me affected by irrigation Diversion”

The Draft Policy proposes that the season of diversion end on March 31. The commenter's concern is for periods outside of the proposed Policy diversion season during which no new diversions would be permitted unless site specific studies indicated that the diversion season for specific projects could be extended with no impact on the fishery resource.

Comment 3.2 Diversion Season, pg. 1

“The literature findings along with the data collected for establishing the limits on seasonal diversion have for the most part been integrated into a scientifically acceptable format for inclusion in the policy. Precedent flow condition and flow peak intervals could potentially be factors” that would need to be considered “in the seasonal diversion limits.”

Antecedent flow conditions reflect basin hydrologic processes and result in the observed hydrograph, and are not affected by diversion. The Policy is based on habitat-flow needs, which are of a certain level irrespective of antecedent flow conditions. Flood frequency is addressed through the MCD element.

Comment 3.3 Minimum Bypass Flow, pg. 2

“Minimum bypass flow requirements have several components to their implementation. The first is the maintenance flow downstream from the barrier and the second being the access. ...There are other factors associated with barriers, which are potentially important protectiveness issues such as sediment supply, temperature, early life stage predation, etc.”

These factors are addressed generally in Chapter 8 and Appendix D of the Task 3 report.

Comment 3.4 Maximum Cumulative Diversion, pg. 2

“Groundwater recharge and abstraction (changes in interflow) have not been included in the policy for establishing maximum diversion requirements and could factor in considering the conjunctive relationship with high stream and diversion rates. The recharging of the groundwater during the high flow period charges the near stream groundwater storage, which then charges the interflow for groundwater flows back to the stream as the stage of the river recedes. Without data analysis the question is whether this potential is reflected in the MCD rates?”

The Policy provides for an MCD of 5% of the 1.5 year instantaneous peak flow. The Policy guidelines for calculating the 1.5 year peak flow allow for use of streamflow records, regression methods, or other methods acceptable to the State Water Board. Embedded in the resulting calculations using these methods are the effects of near stream groundwater storage.

Comment 3.5 Site Specific Studies, pg. 2

“The site-specific studies are the most valuable elements of the policy... Exactly how the findings of the site-specific studies can be translated (curve fitting, etc.) into other watersheds in the three county areas is problematic.”

Staff agrees and points out that this is a reason why site-specific studies and an effectiveness monitoring program are important parts of the Policy. Regionalization of site specific study data is not being contemplated in the initial draft policy, but could be considered when the policy undergoes periodic review.

Comment 3.6 Cumulative Effects, pg. 2

“Without a sensitivity analysis ... discrimination between effects and policy are not clear...It appears that one size doesn’t fit all when it comes to the flow alternatives. There is no discussion on how the different flow alternatives collectively (all species considered) would be implemented.”

As described in Appendix D of the Task 3 report, the Policy is based on the recognition that one size does not fit all when it comes to a regionally protective instream flow criteria. This is one reason why it is important that the MBF element, in particular, be regionally conservative, with the allowance that a site-specific study may be done to more precisely determine instream requirements at a specific location.

Comment 3.7 Onstream Dams, pg. 2

“Minimizing the effects of on-stream dam is a necessary but not sufficient element of the policy for protectiveness of salmon species... This should be the easiest of the elements (to) monitor and enforce.”

Comment noted.

Comment 3.8 Fish Passage Protection, pg. 2

“This is another policy element that is necessary but not sufficient.”

Comment noted.

Comment 3.9.1 General Implementation Questions, pg. 3

“It is not clear if unimpaired flow represents the same resource distribution as undeleted or native base flows. If the unimpaired only removed the diversions and did not include anthropogenic changes in land use then it is starting the analysis at impaired conditions...The question would be; does the policy developed unimpaired flow condition encompass the close to “natural condition” to afford protectiveness?...Maybe this is not an issue but there is no discussion in the document to alleviate my concern.”

The Policy defines the term “unimpaired flow” as “The stream flow that would naturally occur in a stream channel without any diversions or impoundments”, page A-2. Anthropogenic changes in land use are not considered.

Comment 3.9.2 General Implementation Questions, pg. 3

“Are water rights grandfathered into this policy?... This is exactly the issue on the Upper Klamath in Oregon where water right adjudications are under way. A general observation in the Oregon processes is that the water rights were 1) over allocated, 2) unmeasured, and 3) mostly unregulated...”

The Draft Policy applies to new and pending water right applications, and existing authorized diverters that file petitions for change.

Comment 3.9.3 General Implementation Questions, pg. 3

“I am not sure how one could answer ...questions “ of future uncertainty in protectiveness “unless the policy left open an adaptive approach to the implementation of the guidelines.”

Uncertainties such as future impacts of climate change will not change habitat-flow requirements of anadromous salmonids, but could change water availability and water temperature. This comment highlights the importance of basing the Policy on adaptive management principles, by including elements of conservative protection levels, site-specific studies, and an effectiveness monitoring program.

Comment 3.9.4 General Implementation Questions, pg. 3

Need more detailed assessment of the extent to which sites used in developing the policy have experienced significant land use changes from natural conditions.

The issue of predicting effects of land use changes on flow is complex and requires detailed site-specific analysis, large scale data collection, and computer modeling that were beyond the scope and budgetary constraints of developing a regional policy for establishing protective instream flow levels. However, with the possible exception of channel incision resulting from changes in land use, the relationship between channel form, hydraulics, and anadromous salmonid habitat-flow needs should be similar irrespective of land use changes. For example, while the amount of spawning habitat available may differ between a channel’s former and currently incised state, where such habitat exists the general habitat-flow relationships to the left of the peak of the curves in Figures D-1 and E-7 should be similar for the two states. The issue of land use change therefore mostly affects the estimation of mean annual flow, although in this case the estimated value for pre-development and current states should be within prediction error intervals (assuming similar mean annual precipitation and unimpaired flows).

Comment 3.9.5 General Implementation Questions, pg. 3

“The issue of implementation of the Policy is problematic. An implementation option might be to prioritize stream reaches, instrument them, implement the full range and coverage of management practices, and then measure effectiveness...The question might be how and where to invest infrastructure and monitoring effectiveness with the probability of success at its greatest?”

The Task 3 Report provides recommendations for effectiveness monitoring program implementation; however, the State Water Board currently does not have the staff or funding to support an effectiveness monitoring program. If such a program were to be implemented in the future, prioritization of implementation on specific stream reaches could be considered.

Comment 3.9.6 General Implementation Questions, pg. 4

Figure was provided in letter to supplement comment regarding the problem of compounding effects of diversions in the downstream direction for the case when baseline flow levels are reduced to reflect the diversion upstream. The baseline flow for calculating diversions downstream should remain as if the upstream diversions were not in operation.

Staff recognizes that as diversions in a watershed increase, gaged stream flows and the resulting estimates of the mean annual flow will decrease. For this reason, the Policy specifies that the minimum bypass flow and maximum cumulative diversion shall be calculated based on the unimpaired mean annual flow at any point in the basin.

The Policy also limits the total allowable diversion from a watershed, including all existing upstream diversions to the maximum cumulative diversion to prevent the excessive compounding effects of diversions. The maximum cumulative diversion is equal to 5 percent of the 1.5-year instantaneous peak flow.

Staff thanks the reviewer for his comments.

Reviewer 4. Dr. Margaret Lang, Professor Environmental Resources Engineering, Humboldt State University

Comment 4.0.1 General Comments, pg 2.

“The draft *Policy for Maintaining Instream Flows in Northern California Coastal Streams* is a major step forward in the protection of anadromous fisheries resources for Northern California Coastal Streams. If the proposed regulations are adopted and enforced this could mean a significant improvement for aquatic resources in the region. “

Comment noted.

Comment 4.0.2 General Comments, pg 2.

“Climate change was not mentioned in the draft policy...recognition that past conditions may not be representative is important. This could be especially relevant for site-specific studies relying on historical data or the regional regression equations of Waananen and Crippen (1977), which have not been updated for over 30 years.”

Staff acknowledges that past conditions may not be representative of future conditions, which is why the Policy is based on adaptive management principles, by including elements of conservative protection levels, site specific studies, and an effectiveness monitoring program. For this and other reasons stemming from uncertainty, the Policy allows flexibility in the water right application process by allowing water right applicants to develop site specific criteria for use in lieu of the regional criteria, and alternative calculation methods, if available. For example, Section A.5.2.3, method B states that the most accurate regional regression method available shall be used.

Comment 4.0.3 General Comments, pg 2.

“Though difficult to directly address through regulation, the draft policy could be strengthened and supported by clear monitoring goals. Monitoring goals are especially important because over-allocation of water has already occurred in many watersheds and unpermitted diversions present an additional stress...Success of adaptive management relies on clear policy objectives and data as well as regular evaluation and reassessment of the policy’s objectives. A schedule for review or regular summary of the policy effectiveness, perhaps with specific projects as examples, is recommended.”

Chapter 10 and Appendix K of the Task 3 report present desired effectiveness monitoring goals and outline a process for achieving successful adaptive management.

Comment 4.1.1 Diversion Season, pg 2.

“...reliable rainfall does not begin until late-November to mid-December. Thus, the December 15 start date is much more likely to prevent water diversion during the extreme low flows present before the onset of consistent rainfall.”

The Policy will not allow water diversion to occur during extreme low flows, as these are typically below the MBF level, irrespective of an October or December start date.

Comment 4.1.2 Diversion Season, pg 2-3, and Minimum Bypass Flow, pg 4.

“...the MBFs were selected to provide minimal flow requirements to meet spawning and upstream passage needs. There is ...evidence that there are other important benefits to instream flows (e.g. food production/availability, maintaining water quality) that are especially important to late summer/early fall conditions in Northern California coastal streams. “ Study of Harvey et al. (2006) was cited suggesting that growth rates of juvenile salmonids could be affected by diversion, where “invertebrate drift, or food availability, was much higher in the undiverted stream reaches.. Growth of salmonids is very highly related to survival; thus, the assumption that maintaining instream flows only for upstream passage and spawning is protective of anadromous salmonids may not be appropriate. “ Also cited Lobon-Cervia (2003), where “increased discharge in March apparently increased essential resources for brown trout at or just after emergence. ... protection of fish passage and spawning ...are very important to salmonid viability but there are other needs, e.g. food availability, food delivery from upstream, and hiding cover, that are also important and not as well characterized “

These other important benefits are recognized and discussed in Appendix D of the Task 3 report. Regarding water quality, the Policy was developed to avoid adverse effects on water temperatures, the primary water quality parameter that may be influenced by flows under the Policy. Other water quality parameters such as dissolved oxygen, pH, turbidity, and pollutants are not likely to be adversely affected during winter flows and are under separate regulatory authority.

Regarding juvenile growth, the Harvey et al. (2006) study is not representative of conditions expected when following the proposed Policy diversion season, MBF and MCD elements. That study involved summer diversion of the majority of low flow. This case will never occur during the winter diversion season under the Policy. The winter base flow is below the proposed MBF level in streams where juvenile over-wintering occurs. Furthermore, growth rates of juveniles are generally reduced or negligible during the winter depending on water temperature and food availability patterns. During the spring growth period, the diversion season element protects water temperatures conducive to growth, the MBF element of the Policy protects flows that are important for food production and hiding cover, and the MCD element protects freshets that are important for food production and delivery. The MCD element also provides for the essential resources referred to by citing Lobon-Cervia (2003), who were addressing availability of habitat space, not food supply.

Comment 4.1.3 Diversion Season, pg 3.

“...the likelihood of having water available for diversion in October is low. For most watersheds, the early fall storms replenish soil moisture but do not significantly increase instream flows. Thus, expectations should be clearly spelled out to applicants. A possible alternative is to tie diversion timing to actual and persistent flow increases. “

Staff recognizes that seasonal stream flow patterns vary throughout the Policy area and that high instream flows are not guaranteed to be present during the diversion season of

October 1 to March 31. It is for this reason that diversions are not allowed until the minimum bypass criteria is met, to ensure that adequate minimum stream flows are available to provide habitat for fish spawning and upstream passage.

Each applicant is required to submit a water availability analysis that includes an instream flow analysis. This analysis will demonstrate to both the applicant and the State Water Board whether or not water is available for appropriation.

Comment 4.2.1 Minimum Bypass Flow, pg 3.

“...the value presented in the draft policy ($0.6Q_m$ or a function of drainage area) are not very protective of fisheries resources. Of the studies summarized in the Task 3 Report, Appendix A, p. A-3, the lowest minimum fraction of Q_m suggested for protection of suitable habitat was $0.68Q_m$. Setting the MBF at $0.6Q_m$ provides very minimal protection for fish populations. “

The $0.68Q_m$ value was for Brush Creek, with a drainage area of 16 mi². The draft policy proposes to apply the MBF criterion of $0.60Q_m$ only to much larger rivers, for which the determination of instream flow needs is most difficult, and mechanistic analysis techniques such as PHABSIM become problematic in their application (for example, how does one simulate and relate velocity suitability in deep water to flow when fish can move up and down extensively in the water column?). The data in Appendix E suggest a continually decreasing trend with river size, but it was recognized that the MBF3 trend likely cannot be extrapolated to ever larger basins for which little data exist. Hence, the proposed MBF criterion consists of MBF3 and a cut-off value of $0.6Q_m$ for larger watersheds. $0.60Q_m$ was proposed for large basin areas because general professional experience with instream flow studies indicated it was an acceptable lower limit that would be protective of fish.

Comment 4.2.2 Minimum Bypass Flow, pg 3-4.

“The draft policy’s method for estimation of the minimum bypass flows is also likely to have considerable error for many streams. The draft policy’s recognition that larger relative flows are needed for passage and spawning in smaller watersheds and developing relationships that include this drainage area dependence is a major improvement. However, few data are available to verify these relationships. Additional data collection on small stream hydrology and fish usage is needed to verify these relationships. “

Staff agrees that additional data on small stream habitat-flow relationships would be helpful. This can occur through compilation of data accumulated from site-specific studies that may be submitted in accordance with the Policy, and through an effectiveness monitoring program.

Comment 4.2.3 Minimum Bypass Flow, pg 4.

The recommended methods for establishing Q_m in the absence of actual gage data may have significant error... at lower flows, more subtle factors such as watershed geology, slopes, ground cover, soil thickness, etc. influence the stream flow. The mean annual flow is as much a function

of storm flows as low flows that do not generally correlate as well to drainage area. These relationships also need additional data collection and verification.”

Staff recognizes that in the absence of data, the methods for establishing mean annual flow may not be precisely accurate. However, the methods were written to be uniformly applicable over the region and to provide a reasonable estimate. If methods are not applicable to a specific site, the Policy allows flexibility in the water right application methodology by allowing for site-specific studies and alternative calculation methods.

Comment 4.2.4 Minimum Bypass Flow, pg 4.

“Gage data for many watersheds are sparse. The draft policy’s suggested estimation methods would require using many gages that have records of less than the 10 years, which introduces major uncertainties. “

Please see response to comment 4.2.3.

Comment 4.3.1 Maximum Cumulative Diversion, pg 4

“The maximum cumulative diversion requirement proposed, 5% of the unimpaired 1.5-yr instantaneous peak flow, is probably a reasonably protective limitation for maintaining channel maintenance flows.”

Comment noted.

Comment 4.3.2 Maximum Cumulative Diversion, pg 4

“...analysis showed that by removing 5% of $Q_{1.5\text{-yr}}$ as the draft policy allows, a flow with return period of 1.59 to 1.63 years is needed to deliver the unimpaired $Q_{1.5\text{-yr}}$. The frequency difference between 1.5 and 1.6 years is likely insignificant. It might be worthwhile to repeat this analysis with data from several specific stream gages. “

Staff points out that this type of analysis was considered during the early development of the MCD alternatives. See Section 7.1.5.2, Scouring Flows (p. 7-7) in the Task 3 report for a discussion of a similar analysis using regional flood frequency regressions.

Comment 4.3.3 Maximum Cumulative Diversion, pg 4

“The draft policy text does not clearly state that maximum cumulative diversion is 5% of the *unimpaired* 1.5-yr instantaneous peak flow and this becomes clear only in Appendix 1, Section A.5.2.3. It should be clearly stated in the policy text, too. “

Staff will consider adding language to Section 2.3.3 and Section A.5.2.3 in the description of the regional criteria for the maximum cumulative diversion to clearly state that the maximum cumulative diversion is 5% of the unimpaired 1.5-year instantaneous peak flow.

Comment 4.3.4 Maximum Cumulative Diversion, pg 4-5

“The analysis ...clearly shows that maximum cumulative diversion limits set as volumes failed to meet the stated criteria of providing for channel maintenance flows. Stating the criteria as a volume would not meet objectives of the policy. “

Comment noted.

Comment 4.4.1 Site Specific Studies, pg 5

“Allowing applicants to perform site specific studies is a good idea if the study quality is confirmed by Water Board staff and other agencies as needed. The potential for data sharing between relevant agencies should also be recognized and taken advantage of when site specific studies are conducted. “

Comment noted.

Comment 4.4.2 Site Specific Studies, pg 5

“...the guidelines for the site specific studies do not include a measure or indication of the climatic conditions under which the site-specific observations were collected. Variances in diversion season may appear favorable if the two years of site specific data were collected in a wet period versus a dry period. “

Staff will consider adding additional language to the Policy to clarify the requirements of a site-specific study. One of those requirements could be descriptions of appropriate hydrologic year types during which the studies take place.

Comment 4.4.3 Site Specific Studies, pg 5

“The site-specific analyses rely on the expertise of a Water Board-approved fisheries biologist. ...there are some tasks such as hydraulic analysis and hydrologic assessment and data collection that require expertise other than fisheries biology...The Water Board should recognize the possible need for multidisciplinary contributions to the site specific study when approving professionals for these tasks. “

Staff will consider adding additional language to the Policy to clarify the requirements of a site-specific study that may include relevant expertise of the individuals conducting the study.

Comment 4.5.1 Cumulative Effects, pg 5

“Policies to address some of the cumulative effects of diversions are a major improvement of the draft policy. Implementation of a maximum cumulative diversion rate is an important policy. In addition, selection of appropriate and limiting POIs will best monitor and mitigate for cumulative effects. When possible, POIs should be selected with input from DFG/NMFS, and locations where either man-made or natural passage and spawning limitations or problems have been identified in

the past should be selected. When identified, these locations should also be considered for permanent monitoring sites. “

Comment noted. Use of POIs as permanent monitoring sites could be considered in a policy effectiveness monitoring program.

Comment 4.5.2 Cumulative Effects, pg 5

“Requiring applicants to use existing databases such as the CalFish web-based databases . . . to identify known barriers on streams with proposed diversion would help identify possible passage POIs.”

Staff encourages use of existing data to the fullest extent to identify possible barriers in the determination of the upper limit of anadromy, as described in Section A.3.0.

Comment 4.6 Onstream Dams, pg. 6

“If adopted, the requirements of the draft policy should minimize the effects of onstream dams. Because many of the mitigation policies ... can be quite expensive and the disruption of natural processes by onstream dams is extensive, onstream dams should be discouraged.”

Comment noted.

Comment 4.7 Fish Passage Protection, pg. 6

“DFG and NMFS ...criteria for fish passage and screening ...should be enforced at all diversions that affect fish passage. Section 4.3 of the draft policy allowing applicants to petition these requirements with consultation and assessment of the project by DFG, and sufficient proof from the applicant and DFG of this evaluation is reasonable.”

Comment noted.

Comment 4.8 Other Fish Species, pg. 6

“Whether the criteria developed to protect anadromous fish habitat satisfies the needs of other native fish should be addressed by fisheries biologists and appropriate field observations.”

The primary fish-related regulatory driver behind the Policy is the Endangered Species Act, which has led to the listing of the three anadromous species of concern in the Policy area. The possibility of effects on other species was recognized in the development of the Policy elements, and is addressed in the SED. This comment highlights the importance of the policy effectiveness monitoring program.

Staff thanks the reviewer for her comments.

Reviewer 5. Dr. Thomas McMahon, Professor of Fisheries, Montana State University

Comment 5.1.1 Diversion Season, pg 2

“I found the analysis of protectiveness for diversion season relative to upstream passage, spawning and incubation habitat, juvenile winter rearing habitat, outmigration, and riparian and channel maintenance to be based on solid biological information for all three target species. I also found the reasoning for ending the season on March 31 to be well supported.”

Comment noted.

Comment 5.1.2 Diversion Season, pg 2

“The year-round alternative (DS2) was not considered a feasible option...This seemed a biologically justifiable, risk-averse conclusion, though the question ... of the feasibility of enforcing a diversion season, regardless of length, seemed to have merit”

Comment noted.

Comment 5.1.3 Diversion Season, pg 2

“The main argument against an earlier diversion start date is to protect the earliest fall freshets, which are critical for triggering upstream migration and of extent of access to small tributaries for spawning, particularly by steelhead First fall freshets often are critical too for channel restructuring and gravel sorting, and flooding of, and seasonal access to, floodplain wetlands.”

The main argument against an earlier diversion start date than October 1 was the prevention of increased temperature impacts. The comment therefore applies to flows between October 1 and December 15 when water temperatures do not appear to be adverse for listed salmonids. The proposed MCD element preserves the pulse-flow nature of freshets thought to stimulate upstream migration, and the MBF element provides for suitable upstream passage conditions irrespective of whether or when diversion occurs.

The early, first fall freshets prior to December 15 are typically smaller in magnitude and duration than peak flows occurring after, and are less likely to result in overbank flow and connection with the floodplain. Some early freshets in some years may be of a magnitude such that the amount of diversion allowed may result in a flow that falls below the unimpaired level needed to disturb gravel or top the streambank. However, the process of channel maintenance is cumulative and the MCD element as a whole protects channel maintenance functions overall.

A significant fraction of streams in the most heavily diverted areas are incised, and flows during the early fall freshets are generally too small to engage the floodplain. Streams in the more northern coastal parts of the Policy area are less affected by incision, but are also less heavily diverted. There is a risk that increased diversion in some streams while following the proposed Policy MBF and MCD elements could result occasionally in

effects to floodplain connectivity, but the nature of such effects and their biological significance is unclear because of the relatively small changes in peak flows that occur as a result of the MCD element.

Comment 5.1.4 Diversion Season, pg 2

“The hydrograph analysis for MCD supports the...assumption that early freshets would be protected under an adequate MBF and MCD scenario...However, one possible limitation to this analysis was that there was no direct comparison of impaired and unimpaired hydrographs using the two different diversion seasons with all else equal.”

Staff acknowledges the absence of this comparison, points out that AB2121 timing requirements and State budgetary constraints precluded an “all permutation” style analysis (i.e., all possible combinations of DS, MBF, and MCD alternatives). Thus the Flow Alternative Scenario combinations that were carefully selected for analysis reflected a strategic set of combinations from which an optimal combination could be deduced.

Due to this comment and others from the fisheries agencies and Regional Boards that recommended further erring on the side of caution in regard to the start of the diversion season with respect to effects on water quality, upstream passage behavior, and potential effects on fall spawning habitat and habitat connectivity, Staff is considering whether to modify the diversion season to start on December 15.

Comment 5.1.5 Diversion Season, pg 2-3

“Implementation of a diversion season along with the proposed MBF and MCD standards to maintain the fall-winter hydrograph could offer a false sense of protection to the listed species if flow levels during other seasons are insufficient to support the completion of rest of the freshwater life cycle.”

The Policy applies to pending and future water right applications, and petitions. Water rights issued prior to endangered species listings were not subject to diversion season limitations, therefore spring and summer flows may already be impaired by existing water diversions. For existing flow impairments, the State Water Board may exercise its authority under the doctrines of reasonable use and the public trust to address diversions of surface water or groundwater that reduce instream flows in the Policy Area and thus adversely affect fish, wildlife, or other instream beneficial uses.

Comment 5.2.1 Minimum Bypass Flow, pg 3

“I found that the biological flow needs were based on a thorough review of the literature, explained in detail in Appendix D, and I didn’t find any major literature absent from their analysis that would have altered any of the assumptions used to derive passage and spawning flow needs.”

Comment noted.

Comment 5.2.2 Minimum Bypass Flow, pg 3

“Passage flow criteria were appropriately derived using steelhead as an ‘indicator species’...and it is notable that a more conservative minimum spawning depth was used in the analysis (0.8 ft vs. 0.7 ft in most previous studies). Spawning habitat flow criteria seemed to be based on well-supported information on suitable depths, velocities, and substrates.”

Staff adds that conservative depth criteria were selected, in part, to help offset uncertainty in other parts of the data collection and analysis, including that associated with sampling a small number of transects, limited hydraulic data collected to base the hydraulic-habitat simulations on, and inherent variability in defining habitat-flow relations across sites and streams.

Comment 5.2.3 Minimum Bypass Flow, pg 3-4

“For the biological criteria, the only potential limitation I found was with the assertion that juvenile anadromous salmonid winter rearing habitat was assumed to be protected if the flows provided by the MBF protected spawning and incubation habitat... In the summer, rearing juvenile salmon and steelhead choose velocity and depth microhabitats largely in the middle of open channels, much like spawners do. However, in winter, the position of these microhabitats becomes much more restrictive in the sense that suitable depths and velocities are not occupied unless located underneath banks or LWD cover... my main question is whether the MBF criteria based on passage and spawning flows, fully ‘wet’ the undercuts and bank habitats used as winter habitat. ... side channels, alcoves, and seasonally flooded wetlands are also critical winter habitats, but it is unclear if these habitats would be fully wetted by MBF flows as well. ... However, ... winter temperatures are well above” the 7°C level at which studies have noted juvenile habitat shifts to cover, “suggesting that juveniles in Region streams may well be active and out of cover in these warmer winter conditions. ...there seems to be sufficient uncertainty to question whether the assumption that passage and spawning flows are protective of winter habitat is truly valid, without some further information and analysis. While the ‘further information’ might have to wait for knowledge gained during future adaptive management and hopefully specific winter habitat research in the study area, it seems that some simple modeling of flow height in relation to the bank could be done provisionally to see to what extent banks are wetted at the designated MBF levels. For example, it might be possible to run a wetted perimeter analysis (Reinfelds et al. 2004), based on the information collected at the field validation transects, to determine if stream banks will have adequate water depth to fully wet undercut banks at MBF levels established for passage and spawning.”

See response to comment 4.1.2 regarding winter flows and growth of juveniles.

The magnitude of the proposed MBF is such that it is higher than winter base flows in streams where rearing juvenile salmonids are likely to be found and where undercut banks and LWD provide habitat. Hence, juveniles will encounter winter low flow habitat conditions under the Policy that are effectively unchanged (or improved after considering non-permitted diversions), and their access to such habitat structure will likely remain unchanged (or improved) as well.

It is unlikely that the MBF will fully wet side channels and seasonally flooded wetlands. This possibility was discussed in Chapter 4 and Appendix D of the Task 3 report. The habitat flow needs relationship for such habitat is highly site-specific. However, the MCD

element allows for periodic connection to such habitat through the preservation of high flow events, and therefore accessibility will be maintained under the Policy.

The uncertainty concerning effects to juveniles can be addressed through an effectiveness monitoring program.

Comment 5.2.4 Minimum Bypass Flow, pg 4-5

“Overall, I found the development of the MBF3 regression model quite innovative. The rather complicated analysis that was performed utilizing a rather diverse array of new field data and existing literature values was clearly explained and in my opinion based on sound science.... [T]he good regression fit across different regional datasets suggests that the relationship is a fairly good generalization of suitable passage and spawning flows for anadromous salmonids. The Report explicitly recognized the limited time frame of sampling of only a few days and the potential of considerable extrapolation error... Nevertheless, ... there remains a fair degree of uncertainty about how well predicted MBF’s will match with observed MBF’s after implementation of the instream flow rules.”

This comment highlights the importance of having both a conservative MBF and site-specific study as part of a regional instream flow Policy. The MBF3 relation proposed appears to provide the necessary conservative level for protecting instream flows regionally, and is not expected to accurately predict flow requirements in all streams; it should over-predict in many streams (see responses to Burt comments 2.2.2 and 2.2.3c). The site-specific study provision of the Draft Policy allows water right applicants to more accurately determine local fishery resource instream flow needs based on site-specific studies rather than using the regional criteria in those streams where over-prediction occurs.

Comment 5.2.5 Minimum Bypass Flow, pg 5

“The hydrograph comparison analyses provided a clear and convincing demonstration of how the various flow alternatives influenced the percentage and number of days of passage and spawning habitat restriction compared to unimpaired flows on the validation streams. However, I believe it would be helpful, and make a more objective comparison among flow scenarios, if the data were reported in a table listing the average number and percentage of days based on all sites combined, which would also facilitate a statistical comparison (ANOVA) among the MBF alternatives. Additionally, I would suggest some quantification of the term ‘substantial reduction.’... This term is used to ascertain the level of protectiveness but was not defined.”

A table as suggested could be provided, although it must be cautioned that there are no corresponding, established numeric criteria (for either absolute or percentage change numbers) that would allow for quantification of protectiveness and the term “substantial reduction”. In the absence of such criteria, professional experience and judgment were relied upon when interpreting protectiveness.

Comment 5.3.1 Maximum Cumulative Diversion, pg 5

“Inclusion of an MCD is a progressive facet of the Policy given that most instream flow rules have been set primarily on minimum flow standards alone. The challenge for developing an appropriate

maximum diversion was to derive a metric that is regionally applicable yet capable of assessing to what degree the frequency and magnitude of channel and riparian maintenance high flows are preserved within a region where fall-winter streamflows vary widely across wet, normal, and dry water years.

I found the data, rationale, and analysis used to compare the various alternatives to be well documented and a good faith effort.”

Comment noted.

Comment 5.3.2 Maximum Cumulative Diversion, pg 5

“The analysis convincingly demonstrated that the MCD volume alternative would significantly dampen early high flow events in most years, and nearly eliminate peak flow events in dry years. The analyses of MCD rates...showed that all three alternatives generally protected peak flows across different streams and flow conditions, and supported the objective of protecting the natural flow variability”

Comment noted.

Comment 5.3.3 Maximum Cumulative Diversion, pg 5

“the rationale for scaling the diversion rate to the 1.5-year return peak flow or the 20% winter exceedance flow was an appropriately conservative way to preserve minimum bankfull and channel maintenance flows especially during dry years.”

Comment noted.

Comment 5.3.4 Maximum Cumulative Diversion, pg 6

“The Report noted that there is a high degree of uncertainty in defining a clear threshold between protective and non-protective maximum diversion rates, and, that for all MCD alternatives, effectiveness monitoring is essential.”

Comment noted. Staff acknowledges the uncertainty identified by the reviewer. This comment highlights the importance of having a conservative regional MCD criterion and allowing for site-specific study as part of a regional instream flow Policy.

Comment 5.3.5 Maximum Cumulative Diversion, pg 6

“I didn’t find the rationale for selecting the MCD2 alternative as compelling or sufficiently risk averse as some of the other Policy recommendations... while it seems less restrictive MCD rates could be implemented if so indicated by future monitoring, it seems much less likely they could be decreased. Given that the MCD2 alternative allows for 5-7 times the amount of diversion than the MCD1 rate, and the high level of uncertainty surrounding this element, it would seem that the MCD1 rate, roughly equal to 1% of the 1.5 year flood, might be a more appropriately conservative interim standard.”

Although this peer reviewer recommends erring on the side of more protectiveness for the MCD element, i.e., using MCD1 rather than MCD2, some public comments have expressed concern that MCD2, i.e., 5% of the 1.5 year flood, may be too conservative. The 5% level was originally selected after evaluating the results of analyses depicted in Figure 2-1 and, in part, with the anticipation that recommendations would vary about this level. The selection of the 5% level is discussed in greater depth in section D.3 of the Task 3 report.

Comment 5.4 Site Specific Studies, pg 6

“I did not find specific criteria ... on how” site specific “studies were to be conducted or what information could be collected to determine the upper limit of anadromy, so was unable to address this question.”

Staff will consider adding additional language to the Policy to clarify the requirements of a site-specific study. Information required for determination of the upper limit of anadromy is described in Section A.3.0 of the Draft Policy.

Comment 5.5 Cumulative Effects, pg 6-7

“...there remains a fair bit of uncertainty as to which” MCD “alternative is best in terms of protectiveness. With some qualifications noted..., the MCD2 rate method appears to be protective of the hydrograph, though other rate alternatives may be more so. ... it seems that the protectiveness of this element may hinge more on implementation than on which level is actually chosen. The ‘success’ of any alternative would seem to hinge on close monitoring of diversion rates at all points of diversion. Such monitoring would likely require a fair bit of investment in technology and human resources to accurately measure diversion rates and instream flows throughout a large number of watersheds; perhaps requiring a ‘water manager’ for each watershed to insure that flow rules for diversion season and rates are being followed.”

Comment noted. This comment highlights the importance of an effectiveness monitoring program.

Comment 5.6.1 Onstream Dams, pg 7

“...‘fill and spill’ dams on ephemeral streams have the potential to greatly dampen the early fall/winter freshets important for access to the upper reaches of small spawning tributaries by their capture of the entire flow within the stream until the reservoir is filled, potentially resulting in significant dewatering downstream.”

Comment noted. As the commenter indicated, the Task 3 Report discussed this in the analysis of the CFII, which allows for ‘fill and spill’ operations.

Comment 5.6.2 Onstream Dams, pg 7

“...it was unclear how [the recommended DP3.2 alternative for Class III streams] will maintain the peak flow hydrograph downstream. Perhaps maintenance of peak flows will be protected by inclusion of the MCD requirement, but this was not clear..in the report.”

The commenter is correct. Maintenance of peak flows will be provided by the MCD requirement.

Comment 5.6.3 Onstream Dams, pg 7

“The DFG-NMFS (2002) policy recommendation (DP3.1) seemed to more directly address the peak flow issue by the rule a Class III dam “will cause less than 10% cumulative instantaneous flow impairment at locations where fish are seasonally present.”

The onstream dam provisions of the Draft Policy do not act alone. Onstream dams would also be required to comply with the flow-related criteria of the Draft Policy. The peak flow issue would be addressed through the interaction of the minimum bypass flow and maximum cumulative diversion criteria.

Comment 5.7 Fish Passage Protection, pg. 8

“...incorporating screening evaluation as part of the overall Effectiveness Monitoring Program would be desirable.”

Comment noted. This suggestion could be considered when the State Water Board is able to implement an Effectiveness Monitoring Program.

Comment 5.8.1 Other Fish Species, pg. 8

“One aspect ...that I believe needs some clarification ... is to the apparent distinction between the upper limit of anadromy and upper limits of Class I waters, defined based on the presence of fish.... Some aspects of the Report treat them as one and the same...without further clarification on the distinction between the two boundaries, and some actual field testing of the modeled relationship, the assumption might not hold, particularly if the stream distance separating the two boundaries is large. Following the tenor of the Policy to be ‘conservatively protective’ in the face of uncertainty, my recommendation would be to apply the MBF and MCD rates to all Class I waters.”

The instream flow requirements of the Policy were developed in direct response to AB 2121, which targeted ESA listed anadromous species for protection. The Task 3 report documents the scientific basis of the Policy in protecting listed anadromous salmonids. The regional criteria for minimum bypass flow were formulated based on the drainage area at the upper limit of anadromy, because the goal was to prorate flows in upstream reaches to ensure protective flows for anadromous fish were provided at points of anadromy.

The fish screening and onstream dam criteria are dependant on the stream classification as defined in Section 4.2 of the Policy. The stream classification system were developed to refer to all fish, not only anadromous salmonids in order to protect native species from potentially adverse, direct effects of diversion facilities

Beneficial effects of the Policy in protecting non-anadromous fish species are assumed based on general biological knowledge of their habitat requirements, but suitable

information on habitat-flow requirements was generally scarce and detailed analyses could not be performed for non-salmonid species.

Comment 5.9.1 Conclusions and Recommendations, pg. 8

“The Policy is based on a very comprehensive and well written report. I found the overall scientific and technical basis for the proposed policy to be based on reasonable assumptions and detailed analyses within the constraints posed by incomplete hydrological information, incomplete knowledge about specific habitat needs of salmon and steelhead in the Policy area, limited data collection opportunities, and of the need for broad based regional instream flow rules. The Report makes a good faith effort to address the many previous issues raised in reviews of earlier drafts of the policy, such as questions surrounding basin size, the need for field validation, and incorporating adaptive management and monitoring to reduce uncertainty. The Report provides a very detailed description of assumptions made throughout, and in nearly all cases, of incorporating a ‘risk averse’ strategy where uncertainty is high.”

Comment noted.

Comment 5.9.2 Conclusions and Recommendations, pg. 9

“The detailed monitoring plan is one of the best examples I’ve seen on how to plan and implement adaptive management. If fully implemented, I believe it has the potential to become a showcase example of how to manage instream flows within an adaptive management framework.”

Comment noted.

Comment 5.9.3 Conclusions and Recommendations, pg. 9

Recommendation: “Include more direct comparison of MBF’s under different diversion seasons”

A sensitivity study (Stetson and R2, 2009) was performed based on feedback in peer reviewer and public comments. The study compared the potential water diversion volume for 9 different MBF alternatives and number of days of spawning and passage opportunities for 5 of the MBF alternatives. Given numerous public comments expressing concern regarding the protectiveness of an October 1 start date for the diversion season, a diversion season of December 15 to March 31 was used for the study instead of the October 1 to March 31 proposed in the Draft Policy. Based on the results of the sensitivity study, it was concluded that an MBF criterion based on a 0.7 ft steelhead minimum spawning depth criterion in the validation sites would be similarly protective as one based on a 0.8 ft criterion and would provide a slightly higher potential diversion volume.

Comment 5.9.4 Conclusions and Recommendations, pg. 9

Recommendation: “Further evaluate and analyze the assumption that winter habitat is protected by suitable spawning and passage MBF’s”

This can be evaluated through implementation of an effectiveness monitoring program.

Comment 5.9.5 Conclusions and Recommendations, pg. 9

Recommendation: “Choose a more ‘risk averse’ MCD1 maximum diversion rate than the recommended MCD2 alternative”

Staff believes that the proposed 5% of 1.5 year flood level is a suitable compromise that strikes a balance between water use and instream flow protection and is risk averse for fish.

Comment 5.9.6 Conclusions and Recommendations, pg. 9

Recommendation: “Include discussion of the current state of flows in Policy streams during non-diversion season time periods and how this might influence the implementation and effectiveness of the proposed winter flow diversion Policy”

See response to comment 5.1.5.

Comment 5.9.7 Conclusions and Recommendations, pg. 9

Recommendation: “Add some additional, more quantitative, comparisons of impaired and unimpaired hydrographs”

Due to this comment and others from the fisheries agencies and Regional Boards that recommended further erring on the side of caution in regard to the start of the diversion season with respect to effects on water quality, upstream passage behavior, and potential effects on fall spawning habitat and habitat connectivity, Staff is considering whether to modify the diversion season to start on December 15.

A sensitivity study (Stetson and R2, 2009) was performed based on feedback in peer reviewer and public comments. The study compared the potential water diversion volume for 9 different MBF alternatives and 5 MCD alternatives and calculated the number of days of spawning and passage opportunities for 5 of the MBF alternatives with an MCD of 5% of the 1.5 year peak flow (the Draft Policy regional criteria). A diversion season of December 15 to March 31 was used for the sensitivity study instead of the October 1 to March 31 proposed in the Draft Policy. The study concluded that an MBF criterion based on a 0.7 ft steelhead minimum spawning depth criterion in the validation sites would be similarly protective as one based on a 0.8 ft criterion and would provide a slightly higher potential diversion volume.

Comment 5.9.8 Conclusions and Recommendations, pg. 9

Recommendation: “include further discussion of the distinction between upper limits of anadromy and upper limits of Class I streams and the implications thereof for maintaining minimum and peak flows in both ‘types’ of streams”

The upper limit of a Class I stream marks the farthest upstream extent of fish, while the upper limit of anadromy marks the farthest upstream extent of anadromous fish and, as such be farther downstream of the Class 1 point. Maintaining minimum and peak flows in both “types” of streams is important to provide passage and spawning habitat and channel maintenance processes throughout the entire length of the stream.

Comment 5.9.9 Conclusions and Recommendations, pg. 9

Dr. McMahon recommends that rugged, easily instrumented water level recorders be used to obtain detailed flow data over the entire region.

Staff acknowledges the benefits of using such recorders. Additional flow data, which is a recommended part of an effectiveness monitoring program, would help reduce uncertainty.

Comment 5.9.10 Conclusions and Recommendations, pg. 9-10

Suggests including “a critical reach concept into the monitoring plan... if flows are to be truly protective of the listed species, I believe that maintenance of both surface and subsurface flows in these ‘critical reaches’ will be vital to maintain long-term salmon and steelhead productivity. So directed sampling for identifying these hot spots, and population and flow monitoring directed specifically at these areas, would be desirable.”

Comment noted. This suggestion could be considered for an effectiveness monitoring program.

Staff thanks the reviewer for his comments.

Reviewer 6. Dr. Richard Woodward, Department of Agricultural Economics, Texas A&M University, Review of Draft Policy for Maintaining Instream Flow in Northern California Coastal Streams, February 1, 2008

Comment 6.1.1 Setting seasonal limits, pg. 1

“I was frustrated by the lack of formal and/or statistical treatment of the uncertainty.”

The appropriate level of statistical analysis was considered early in the development of the Policy element alternatives. Originally, the intention was to use available information from a variety of existing reports and data repositories, which would not have supported a consistent, thorough and elaborate statistical analysis or modeling of uncertainty. During Policy development, it became clear that, at a minimum, some new field data were required from Policy area streams, but the AB 2121-mandated time frame and available budget did not allow for an extensive data collection effort nor did they facilitate extensive statistical analyses of the types referred to by the reviewer. See also the response to comment 6.2.1.

Comment 6.1.2 Setting seasonal limits, pg. 1

“There was . . . limited discussion of the possibility of extending the seasonal limits beyond 3/31, and I was unable to tell whether there was truly scientific consensus on the end of the season.”

The reasoning for not extending the seasonal limit beyond March 31 is based on application of biological and physical scientific principles that are well established in the literature regarding water temperature and linkages to salmonid biology as discussed in Section 5.1.4 of the Task 3 Report.

Comment 6.1.3 Setting seasonal limits, pg. 2

“I believe that the analysis is incomplete. . . . The authors do use some results from other scenarios to argue that in general the DS increase does not significantly affect spawning and passage opportunities. But I see no reason why this is not addressed more directly by comparing an alternative with the recommended suite of policies to one with a more restricted diversions season.”

The AB 2121-mandated time frame and available budget precluded an “all permutation” style analysis (i.e., all possible combinations of DS, MBF, and MCD alternatives), thus the Flow Alternative Scenario combinations that were carefully selected and analyzed reflected a strategic set of combinations from which an optimal combination could be deduced.

See response to comment 5.9.7.

Comment 6.2.1 Establishing minimum bypass flow requirements, pg. 2

“...a policy based on a function estimated using a mean regression of protective flow on stream size would only be expected to provide sufficient flows to about 50% of the rivers. On the other hand, a function at the upper end of the 95% confidence interval would be expected to provide sufficient flow in 95% of the cases. This conceptual framework is relatively simplistic because it does not formally address the inherent uncertainties in the data and assumes that a univariate function of the log-linear form proposed is sufficient. Nonetheless, given the need for a relatively simple rule, the conceptual framework seems to be a reasonable structure in which to carry out the analysis.

However, the analysts failed to implement the conceptual framework proposed. What they did was to estimate a log-linear function for MBF3... For the function to be used in the policy, they increased the constant by three standard deviations.... No change is made, however in the estimated slope. This is not consistent with the conceptual model discussed above. While it appears in this case that the 3s shift in the constant term is sufficient to substantially increase the number of observations below the MBF3 line ..., it is also clear that it is not the case that 95% of the observations are below the line. The analysts do not present the standard deviation in the slope parameter; this should be included. A 3 s upward shift in the intercept alone will not necessarily lead to a line that is above 95% of the data...

“what can be done instead of an ad hoc 3σ shift in the constant? ... An alternative would be to carry out a constrained regression in which a log linear function is chosen to minimize the sum of squared errors subject to the constraint that 95% of the errors (estimated minimum flow less observed minimum flow) are negative.”

As explained in the report, the MBF3 and MBF4 alternatives developed in Appendix E were based on the simpler approach of adjusting the intercept. As indicated in the last paragraph of Appendix D, there is no clear mechanistically-based reason for choosing one statistical method or level of confidence over another. For example, the quantile regression approach can be affected by the scatter distribution of points along the line defining the regression and the percentile level evaluated (e.g., Cade et al. 1999), and thus may not necessarily be more robust than performing a simple regression and adjusting the intercept. More complex methods such as Bayesian analysis are also candidate approaches, but require more effort and there is still the question as to whether a line defined by adjusting the intercept by 3 standard errors is less biologically meaningful than say a 95th or 99th credible interval, for example. In lieu of a formal, extensive and more complicated statistical uncertainty analysis based on various assumptions regarding distributions and the like, risk aversion was instead achieved in the Policy MBF element development by defining an upper envelope that appeared reasonably conservative based on experience with typical anadromous salmonid instream flow needs, and allowing variances from the upper envelope based on site-specific studies.

The regression slope parameter was not adjusted in a manner comparable to the intercept because a slope adjustment would either protect smaller streams more and larger streams less, or vice versa depending on whether the slope was adjusted higher or lower.

Citation: Cade, B.S., J.W. Terrell, and R.L. Schroeder. 1999. Estimating effects of limiting factors with regression quantiles. *Ecology* 80(1): 311-323.

Comment 6.2.2 Establishing minimum bypass flow requirements, pgs. 2 & 3

“it was not clear to me that it is appropriate to use the MBF3 function for the full range of the policy area. ... I was unable tell with certainty that there is not significant out-of sample prediction being carried out. ... From [Figure E-9] it would seem that, at least at the boundary, there may be a significant number of streams with drainage basins that are less than one mi². Yet, from the data presented in the figures, the MBF3 function seems to have been estimated almost exclusively on basins greater than 1 mi². If the policy will affect a significant number of streams with drainage area less than 1 mi², then a clearer justification for using the function out-of-sample should be given.”

This problem was recognized in the development of the MBF3 element, but there were insufficient data to enable a detailed evaluation. The one gaged stream sampled (E Fk Russian R) with a drainage area less than 1 mi² did not have spawning habitat at the site visited, but the results for the passage analysis (Figure E-2 in Appendix E of the Task 3 report) suggested that the spawning relationship may similarly be extrapolated and be protective (Figure E-12). However, the point is well taken, and another approach could be to assume streams smaller than 1 mi² require at least as much water as the 1 mi² criterion; i.e., that the regional MBF3 criterion is the same for streams ≤ 1 mi² in drainage area. The question could be answered by site-specific studies in small watersheds, modification of the provisions of the Draft Policy for smaller watersheds using the scientific basis already developed, and/or through an effectiveness monitoring program.

Comment 6.3 Establishing maximum cumulative diversion requirements, pg. 3

“The data available to evaluate the MCD options does not appear to be sufficient to allow for statistical analysis. On average, the proposed MCD restriction seems appropriate given the limited information available. However, from what I could tell the MCD limit does not adjust for year-to-year variation in flow. For example, I was not convinced that allowing diversions up to 5% of 1.5 Year Peak Flood will be protective if droughts persist for several years. Nor am I convinced that the 5% limit is not excessively tight in years that are particularly wet.”

In complying with AB2121 the State Water Board must take in to consideration the practical aspects of implementing the Policy in the context of water rights administration. The Policy, including the MCD limit as written, can be practicably implemented. Implementation of an adjustable, year-to-year MCD would be impractical.

The state of the science of channel maintenance flows is such that a physical basis for adjusting the MCD limit to accommodate year-to-year variation, and thereby identifying an annually variable MCD limiting mechanism that can be tied practically at a regional level to changes in channel morphology, is unavailable (beyond possibly more complex, theoretical sediment transport modeling that could performed on a site-specific basis as part of a site-specific study).

Also see section D.2.6 in Appendix D of the Task 3 report and Dr. McMahon’s review (comments 5.3.2, 5.3.3) for a biologically-based perspective on the importance of managing for wet years. The manner in which the proposed MCD preserves flow variability ensures that the Policy is protective in both wet and dry years.

Comment 6.4 Conducting site-specific studies, pg. 3

“When site-specific studies are used to request a variance from the regional criteria it should be possible to substantially reduce the uncertainty as to the effect of the proposed activities. ... The procedures did appear to be reasonable.”

Comment noted.

Comment 6.5 Assessing the cumulative effects of water diversions, pg. 3

“The process for calculating the cumulative water diversions is section A.5 in appendix 1. ... Although the approach seems reasonable, I did not find anything that I would consider scientific analysis underlying this work. ... I believe the analysis is generally lacking in analysis of how decision makers will respond to the how the incentives created by the Policy. It is my understanding that the marginal value of water withdrawals can be extremely high in this region because of the high-value crops being grown. As such, if the policy creates a situation in which vineyards lose secure access to water they will almost certainly respond by obtaining water in some other way. Analysis of such indirect consequences of the policy would help yield better estimates of cumulative water diversions.”

The Instream Flow Analysis described in section A.5 of the Draft Policy Appendix 1 is provided for water right applicants to determine whether their proposed project in combination with senior diversions could impact the fishery resource instream flow needs in their particular watershed.

The SED Appendix D, Potential Indirect Impacts on Municipal, Industrial and Agricultural Water Use and Related Indirect Impacts on Other Environmental Resources, assesses the potential diversion demand for pending and future water right applications and the potential indirect environmental impacts that might be caused if water supplies under other bases of right are used to meet this potential demand.

Comment 6.6. Minimizing the effects of onstream dams, pg. 3

“The scientific basis of the on-stream dam restrictions appears to be drawn primarily from a review of the literature and professional judgment. ... this approach seems reasonable. ... The monitoring program detailed in Appendix K, if followed, would provide very valuable new data on the impacts of dams in the area.”

Comment noted.

Comment 6.7. Providing passage for fish migration and requiring screening of water diversion intakes, pg. 4

“The screening requirements recommended in this Policy are drawn directly from DFG-NMFS (2002) guidelines. It appears that no additional scientific analysis was carried out in preparation for the Policy.”

Staff acknowledges that no additional scientific analysis was carried out in preparation of the screening requirements. However, screening guidelines established by DFG and NMFS were reviewed for protectiveness. These screening guidelines have been used

extensively for protecting fish at irrigation diversions, hydroelectric facilities, and other water intake facilities throughout California.

Comment 6.8. Application of criteria developed to protect anadromous fishery habitat flow needs to fish habitat, pg. 4

“I did not find any study of the scientific basis for concluding that the provisions intended to protect salmonids will also protect smaller native fish. In terms of habitat, this seems to be a reasonable conclusion.”

See response to comment 4.8 and comments 5.8.1 and 5.9.8.

Comment 6.9.a.1 Big Picture Questions, additional scientific issues, pg. 4

“The reports pay almost no attention to socioeconomic responses that are likely to occur in response to the policies. ... It is likely that water users in the Policy area will alter their schedule of withdrawals, and might even make major changes in how they use and store water in response to the new policy. ... There is no analysis in this document as to whether this Policy might also create such perverse incentives with unintended consequences.”

The potential indirect impacts of the Policy are assessed in the Substitute Environmental Document (SED) Appendix D, Potential Indirect Impacts on Municipal, Industrial and Agricultural Water Use and Related Indirect Impacts on Other Environmental Resources.

Comment 6.9.a.2 Big Picture Questions, additional scientific issues, pg. 5

“Appendix I ... does not include the analysis that would make it most useful. The recommended policy, MBF3, DS3 and MCD2 is not analyzed. ... To be even more valuable, sensitivity analysis on parameters with substantial uncertainty could have been carried out.”

The set of Policy element alternatives that comprise the Draft Policy’s regional criteria was not assessed in a single combination for effects to habitat or water availability during the early development of the draft Policy due to budget and time limitations. However, other combinations of flow alternative scenarios were evaluated in Appendix I of the Task 3 Report. Chapter 4 of the Task 3 Report provided an analysis of the results, and indicated that the Draft Policy’s combination of DS3 (October 1 to March 31), MBF3 (0.8 ft mean regression line plus 3 standard errors), and MCD2 (5% of 1.5 year peak flow) would be largely protective of anadromous salmonid winter habitat needs

In response to this comment and comments of a similar nature received from the public, the proposed Draft Policy regional criteria (DS3, MBF3, and MCD2) were explicitly evaluated for effects to habitat. The results of this analysis (Attachment 1) suggest that the Draft Policy regional criteria (Flow Alternative Scenario 6) result in similar passage and spawning habitat opportunities as Flow Alternative Scenarios 1 (DS1, MBF1, MCD1) and 3 (DS1, MBF3, MCD1) in most of the validation sites, improved in a few validation sites, and reduced in a few other validation sites. Overall, the Draft Policy

regional criteria does not appear to adversely affect spawning habitat opportunities (compared with unimpaired conditions) more frequently than the Flow Alternative Scenarios 1 (DS1, MBF1, MCD1), 2 (DS2, MBF2, MCD4) and 5 (DS1, MBF1, MCD3). Spawning habitat availability is reduced in one validation site for steelhead and coho (Carneros Creek), and three sites for Chinook (Carneros, Dunn and Franz creeks). In the cases where passage opportunities are reduced compared with conditions associated with Flow Alternative Scenarios 1 (DS1, MBF1, MCD1) and 2 (DS2, MBF2, MCD4), the cause appears to reflect the higher MCD rate used by the Draft Policy (MCD2) as indicated by the similarity in results at some sites for Flow Alternative Scenario 4 (DS3, MBF4, MCD2) which also uses MCD2.

These observations suggest that the MCD2 diversion rates appear to represent an approximate threshold in the validation sites, where steelhead and coho spawning habitat is protected or improved in most sites and passage opportunities are reduced for all three anadromous species in a few sites compared with unimpaired flow conditions. Spawning habitat for Chinook is generally improved in larger sites where they might occur. These results suggest that additional increases in MCD above the 5% of the 1.5 year peak flow magnitude could potentially lead to further impacts to passage and spawning habitat opportunities in more sites, although a broader sensitivity analysis would be required to evaluate this threshold effect further. A greater magnitude MCD is therefore not advised without additional study.

In addition, a sensitivity study (Stetson and R2, 2009) was performed based on feedback in peer reviewer and public comments. The study compared the potential water diversion volume for 9 different MBF alternatives and 5 MCD alternatives and calculated the number of days of spawning and passage opportunities for 5 of the MBF alternatives with an MCD of 5% of the 1.5 year peak flow (the Draft Policy regional criteria). Given numerous public comments expressing concern regarding the protectiveness of an October 1 start date for the diversion season, a diversion season of December 15 to March 31 was used for the study instead of the October 1 to March 31 proposed in the Draft Policy. The study concluded that an MBF criterion based on a 0.7 ft steelhead minimum spawning depth criterion in the validation sites would be similarly protective as one based on a 0.8 ft criterion and would provide a slightly higher potential diversion volume.

Comment 6.9.a.3 Big Picture Questions, additional scientific issues, pg. 5

“One of the key elements to maintaining habitat is allowing for sufficient variability during the peak flow period. The policy tool that is used to achieve this result is a limit on the cumulative diversions, primarily because the monitoring requirements required for the Trout Unlimited (MCD4) proposal “effectively requires hourly hydrograph data.” I believe that it would have been useful to consider approximations of this policy, perhaps using models to estimate the hydrograph based on measured data of precipitation. The proposed policy appears likely to achieve the goal of maintaining sufficient variability in flow. However, it is not the ideal tool for the task. In wet years, the criterion must necessarily be more conservative than would be needed if demand could respond to actual conditions and, in dry years, could lead to withdrawals in that might have deleterious impacts on the habitat. A system of rights that vary continuously over time is possible and would be preferable.”

In addition to the following response, please see the response to comment 6.3

The MCD proposal by Trout Unlimited in MTTU (2000) (MCD4) recommends limiting flow diversions with the goal of minimizing the reduction in total time available for spawning. For the Task 3 report, hourly streamflow data were used to calculate this rate for sample 1.5-year flood events at the validation sites, however, the rate which would result in no more than one-half day shortening of flow at the minimum bypass rate would vary for each runoff event. An approximation of this method to determine regionally protective criteria MCD limits would require calculation of the allowable rate from multiple events and selection of the lower limit. This would require more analysis and is targeted to protect the spawning flows which should already be available under a protective MBF, compared to the MCD2 which is directly linked to channel and riparian maintenance flow needs.

A system of water rights that vary continuously over time would be more costly to construct and monitor, and would be more difficult to enforce.

Comment 6.9.b.1 Big Picture Questions, additional scientific issues, pg. 5

“The proposed policy was clearly developed based on a strong knowledge of the science underlying the relationship between instream flows and the life cycle of salmonids. Where available, the analysis built on appropriate data and, where primary data were not available, results from scientific literature was used. It is my impression that there is a fairly strong scientific foundation to believe underlying policy will be protective of the species.”

Comment noted.

Comment 6.9.b.2 Big Picture Questions, additional scientific issues, pg. 5

“there was an insufficient formal treatment of uncertainty. ... Bayesian or robust-control methods could be used to formally analyze uncertainty even when there are relatively few data points.”

See response to comments 6.1.1 and 6.2.1.

Comment 6.9.b.3 Big Picture Questions, additional scientific issues, pg. 5

“there is no analysis of how socioeconomic forces are likely to respond to the incentives created by the proposed policies ... Socioeconomic analysis would have been particularly useful with regard to the enforcement provisions, which rely to a great extent on self-reporting, which lends itself to error and misrepresentation. Furthermore, I believe that it would have been possible to develop a more flexible policy that would still achieve the policy goals, and the lack of economic analysis may have contributed to the failure to identify those opportunities.”

The Policy provides for flexibility in two principal ways. First, the Policy allows water right applicants to more accurately determine local fishery resource instream flow needs based on site-specific studies rather than using the regional criteria. Second, the Policy provides for a watershed approach.

The potential indirect impacts of the Policy are assessed in the Substitute Environmental Document (SED) Appendix D, Potential Indirect Impacts on Municipal, Industrial and Agricultural Water Use and Related Indirect Impacts on Other Environmental Resources.

As a proposed policy for water quality control, the State Water Board is obligated to consider the costs of complying with the proposed policy, including the reasonably foreseeable methods of compliance. This analysis was provided in the Direct Cost Analysis Report.

Staff thanks the reviewer for his comments.

Attachment 1: Updated and Extended Passage and Spawning Habitat Analysis Results

The set of Policy element alternatives that comprise the Draft Policy's regional criteria were not assessed in a single combination for effects to habitat or water availability during the development of the draft Policy, mostly reflecting budget and time limitations. However, other combinations of flow alternative scenarios were evaluated in Appendix I of the Task 3 Report. Chapter 4 of the Task 3 Report provided an analysis of the results, and indicated that the Draft Policy's combination of MBF3 and MCD2 would be largely protective of anadromous salmonid winter habitat needs. Peer reviewers and members of the public commented that the Task 3 report should have provided specific verification of this conclusion.

In June 2009, the passage and spawning habitat analysis described in the Task 3 Report (R2, 2008) was extended to explicitly analyze the proposed Draft Policy regional criteria (DS3, MBF3, and MCD2). This analysis utilized updated MBF3 and MBF4 equations and revised impaired and unimpaired flows for Huichica Creek and Olema Creek.

For the June 2009 analysis, the inputs to the habitat model were updated to correct for the following errors:

1. The MBF3 and MBF4 equations were revised from the March 2008 versions of the equations to correct selected habitat-flow curves and a typographical spreadsheet error. These corrections address comments provided by Wagner and Bonsignore Consulting Engineers in a comment letter dated April 30, 2008¹. In the revisions, the data points were changed for the 0.8 foot regressions at the following validation site transects: Olema Cr Sp1; Huichica Cr Sp1; Carneros Cr Sp2; Dunn Cr Sp1; and Franz Cr Sp1. The typographical errors involved switching of cell values, where Carneros Cr Sp1 was omitted in the regression data and Dry Cr Sp1 was copied twice. The net effect was a small change in the 0.8 foot regression equations used to generate MBF3 and MBF4.

The June 2009 revised and March 2008 versions of the MBF3 and MBF4 equations are:

$$\text{MBF3 (June 2009):} \quad Q_{\text{MBF}} = 9.8 Q_m (\text{DA})^{-0.49}$$

$$\text{MBF3 (Draft Policy, March 2008):} \quad Q_{\text{MBF}} = 9.4 Q_m (\text{DA})^{-0.48}$$

$$\text{MBF4 (June 2009):} \quad Q_{\text{MBF}} = 6.0 Q_m (\text{DA})^{-0.75}$$

$$\text{MBF4 (Task 3 Report, March 2008):} \quad Q_{\text{MBF}} = 5.4 Q_m (\text{DA})^{-0.73}$$

¹ Wagner & Bonsignore Consulting Engineers. A critical review of the December 2007 State Water Resources Control Board Draft Policy for maintaining instream flows in Northern California coastal streams and supporting documents. April 30, 2008.

2. Flows at Huichica Creek and Olema Creek were corrected to represent the drainage area at the transect survey location rather than at the stream flow gage. This change resulted in decreased unimpaired flows and a corresponding change in the impaired flows and passage and spawning opportunities for each Flow Alternative Scenario at Huichica Creek.

Effect of Revisions on the Minimum Bypass Flow

The net effect of the June 2009 changes to MBF3 and MBF4 is a 0.1 to 2 cfs increase in the regional prediction of minimum bypass flow needs at the validation sites as shown in Table 1. The value of the change is dependent on drainage area. Additional details on the revised Draft Policy MBF3 regression is provided in the sensitivity study discussion of the 0.8 ft mean regression plus 3 standard errors. (Stetson and R2, 2009). Revised graphs showing the June 2009 MBF3 and MBF4 regressions similar to those in Appendix E of the Task 3 Report are provided in figures E.1, E.2, E.6, E.8 and E.10 to E.12.

Table 1. MBF3 and MBF4 at the Validation Sites

Validation Site	Drainage Area	Qm	MBF3 March 2008	MBF3 June 2009	MBF4 March 2008	MBF4 June 2009
	(sq. miles)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
E. Fk. Russian River Trib	0.25	0.13	2.4	2.5	1.9	2.2
Dry Creek Trib	1.19	2.2	19	20	10	12
Dunn Creek	1.88	2.5	17	18	9	9
Carneros Creek	2.75	3.8	22	23	10	11
Huichica Creek	4.92	7.4	32	33	12	13
Olema Creek	6.47	13	50	51	18	19
Pine Gulch Creek	7.83	12	42	43	14	15
Warm Springs Creek	12.2	35	99	101	30	32
Santa Rosa Creek	12.5	19	53	54	16	17
Albion River	14.4	20	52	53	15	16
Salmon Creek	15.7	25	63	64	18	19
Franz Creek	15.7	24	60	61	17	18
Lagunitas Creek	34.3	72	124	125	29	30

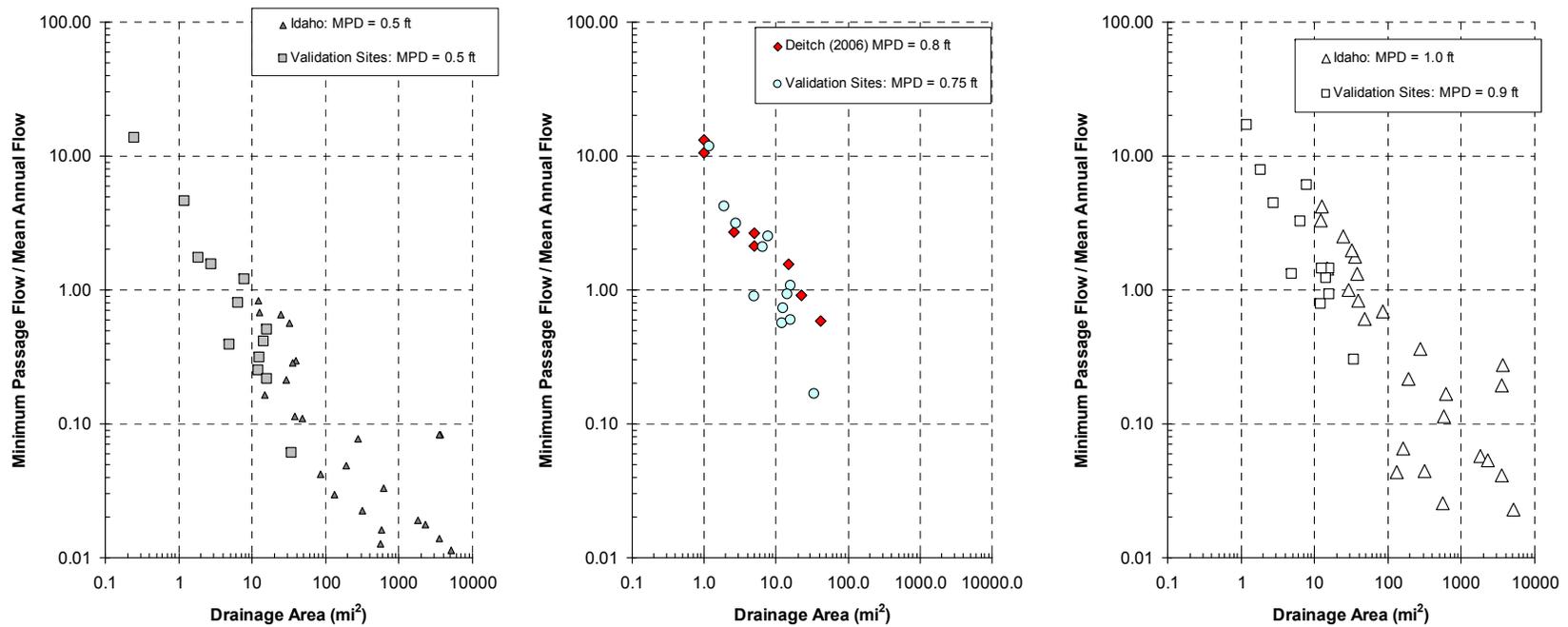


Figure E-1. Variation of estimated minimum upstream passage flow needs, scaled by mean annual flow, with drainage area for selected minimum passage depths (MPD) in riffles.

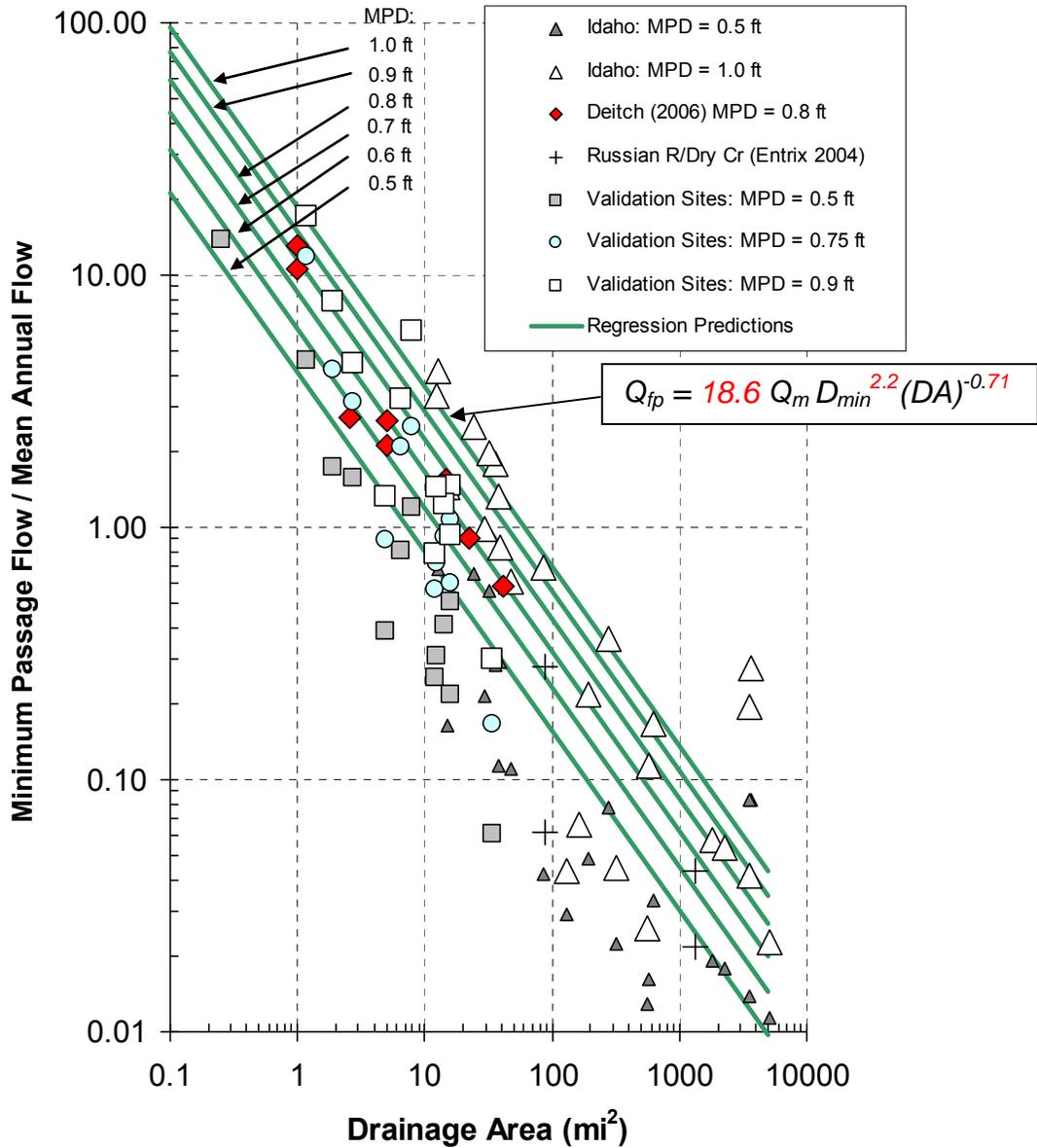


Figure E-2. Comparison of regression predictions for minimum upstream passage flow based on the data presented in Figure E-1r, scaled by mean annual flow and plotted against drainage area. The prediction lines for selected minimum passage depth (MPD) criteria are indicated by arrows.

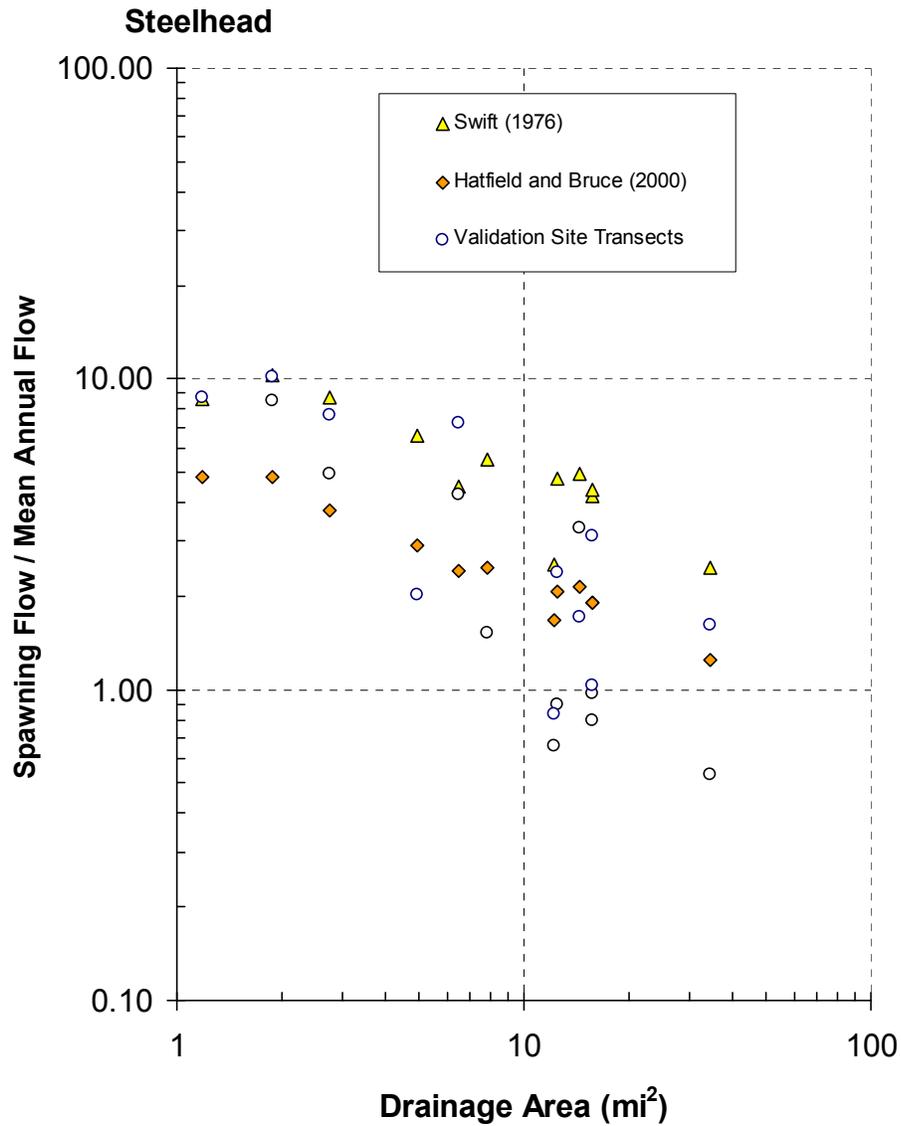


Figure E-6. Comparison of minimum instream flow recommendations for steelhead spawning in Policy area streams sampled in 2006 with predictions based on other regional studies, distinguished by drainage area. The spawning flow is scaled by the approximate unimpaired mean annual flow.

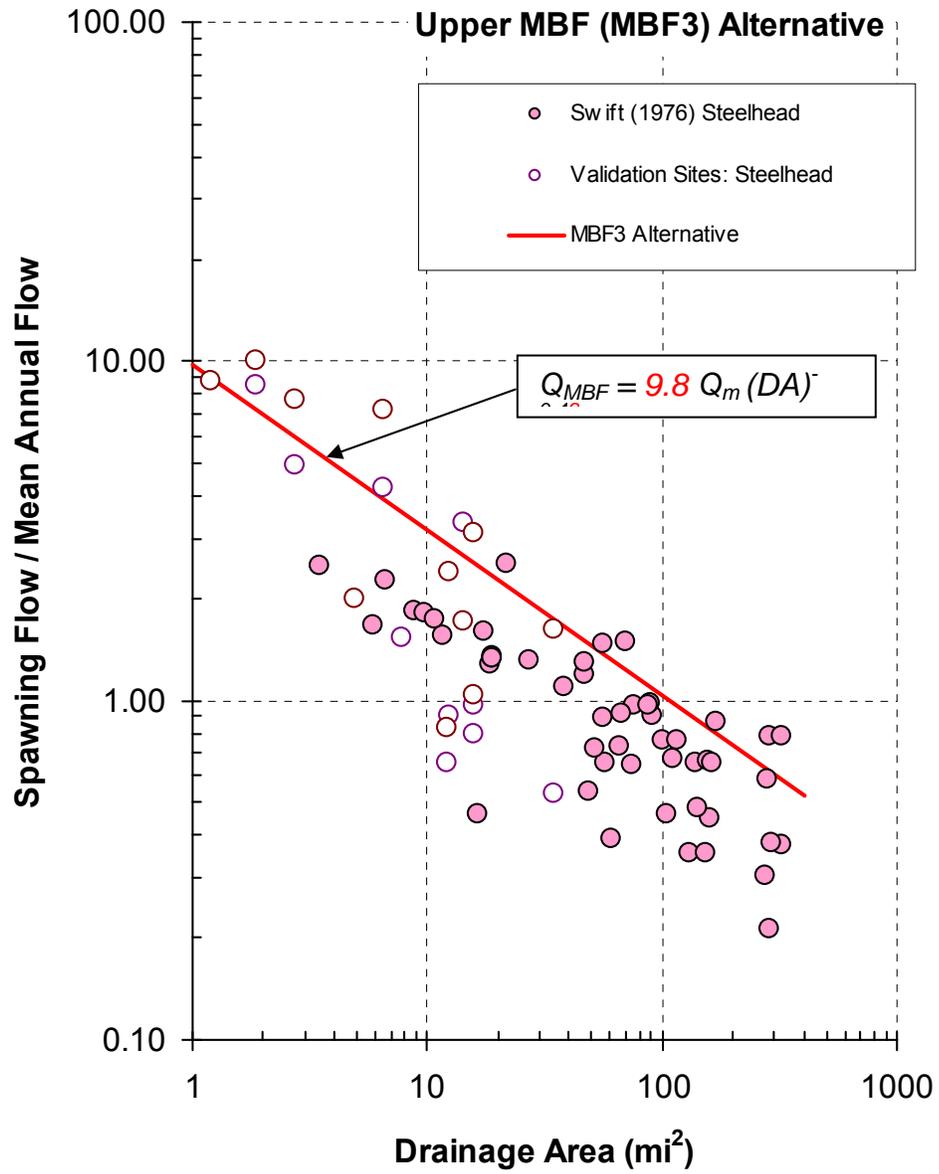


Figure E-8. Upper MBF (MBF3) alternative regression line plotted with the spawning habitat-flow regression data.

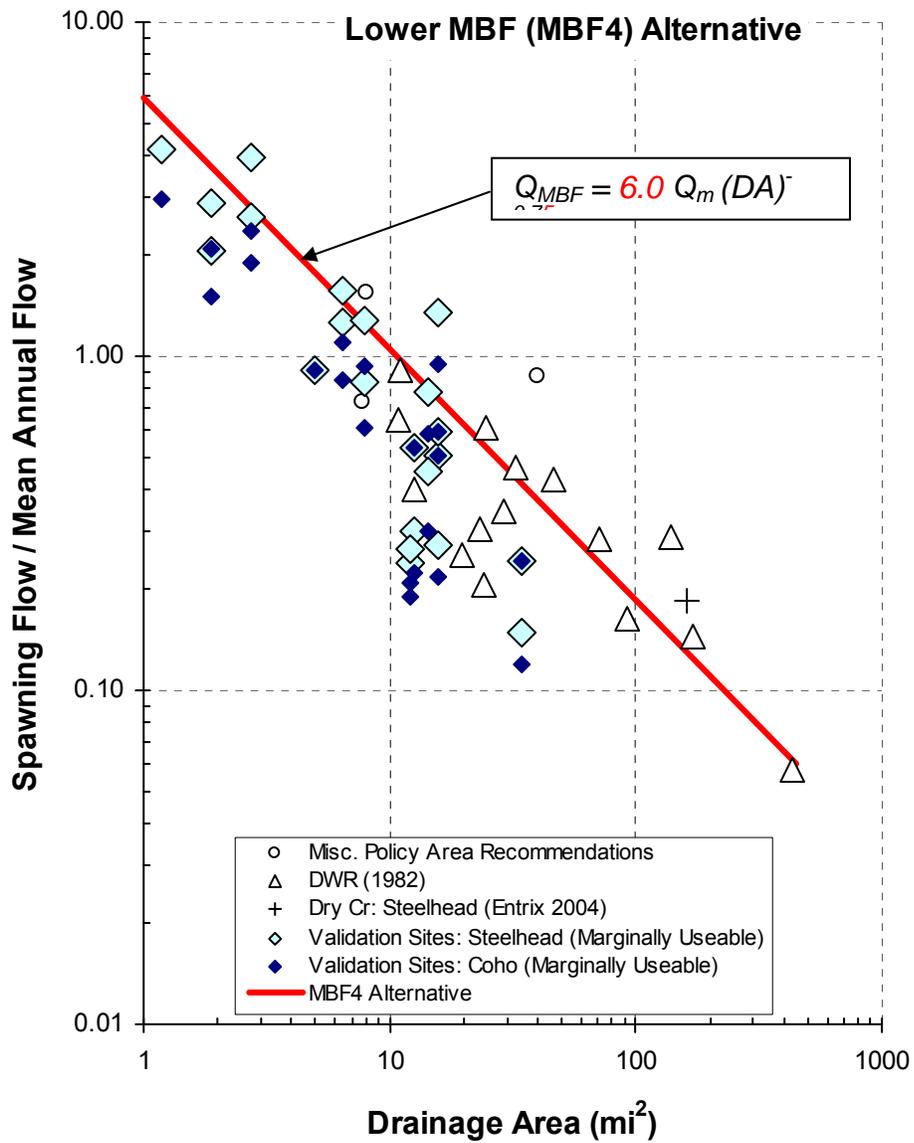


Figure E-10. Lower MBF (MBF4) alternative regression line plotted with the spawning habitat-flow regression data.

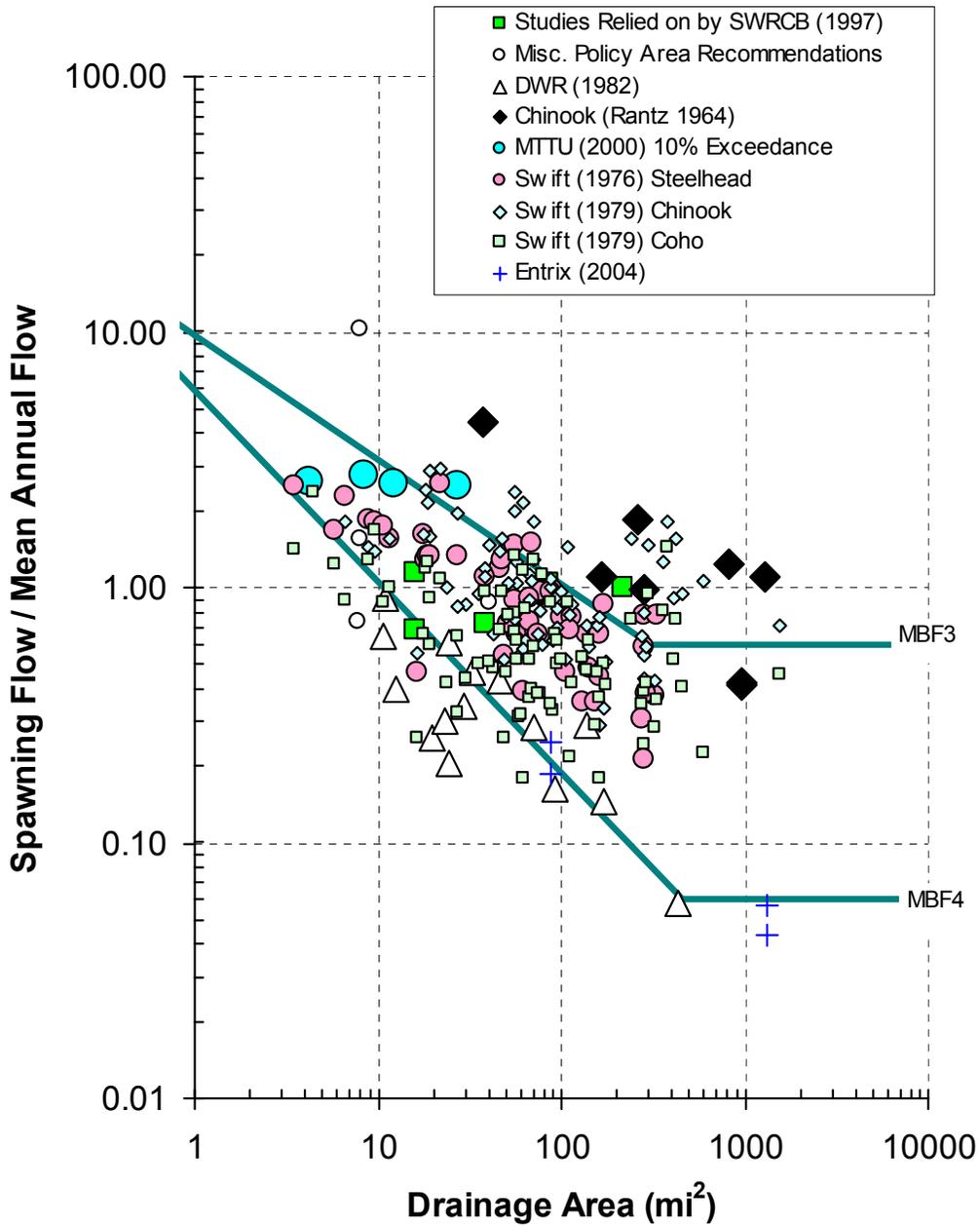


Figure E-11. Upper MBF (MBF3) and Lower MBF (MBF4) alternatives plotted with existing regional and local spawning habitat-flow data.

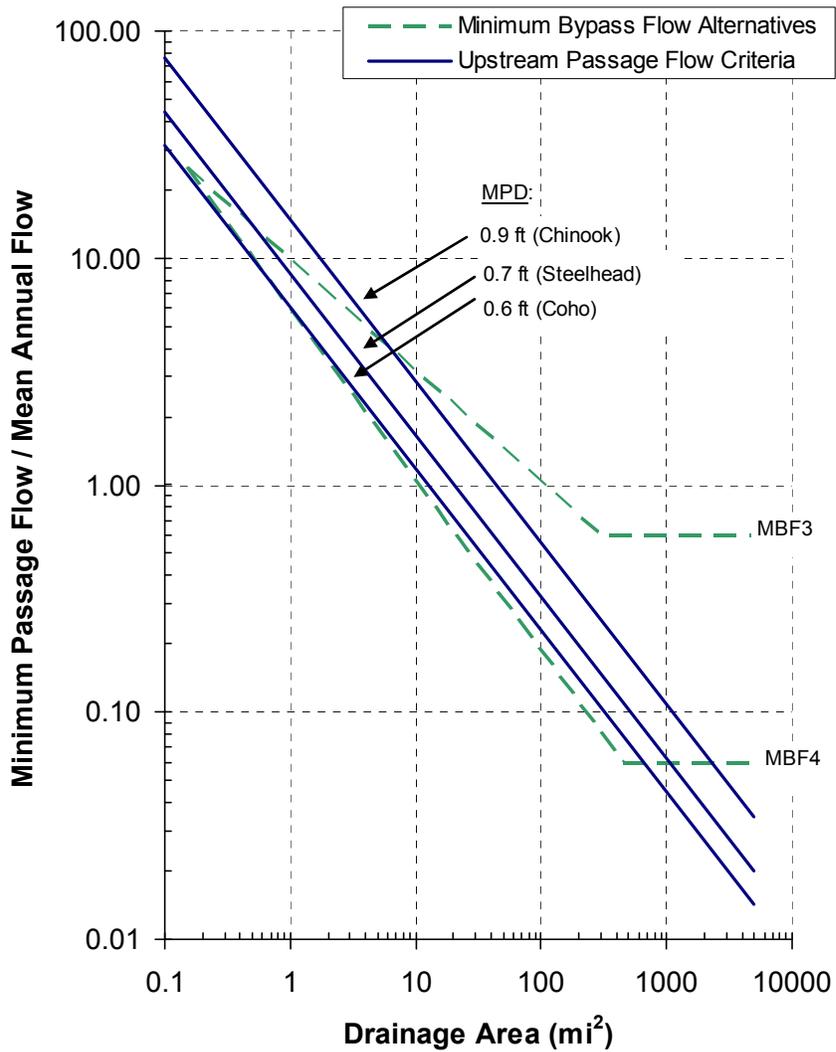


Figure E-12. Comparison of Upper MBF (MBF3; upper dashed line) and Lower MBF (MBF4; lower dashed line) alternatives with upstream passage flow criteria resulting from Equation (E.1) in streams where anadromous salmonids are present. Lines corresponding to specific minimum passage depth (MPD) criteria are indicated by arrows.

Habitat Analysis Flow Scenarios

Table 4-2 lists the Flow Alternative Scenarios that were analyzed². The Task 3 Report documented results for five Flow Scenarios. The extended analysis added the proposed Draft Policy regional criteria as Flow Alternative Scenario 6. Figures 4-6 to 4-8, 4-10 to 4-12, and I-1 to I-13 show the results of the extended and updated passage and spawning habitat analysis³.

Table 4-2. Description of Flow Alternatives Evaluated in the Analysis of Protectiveness.

Flow Alternative Scenario	Description, Policy Element Alternative Criteria Included		
Unimpaired	Flow conditions using the estimated natural hydrology described in the previous section		
Flow Alternative Scenario 1 (NMFS-DFG 2002, MCD rate)	DS2 12/15-3/31	MBF1 February median daily flow	MCD1 rate 15% of 20% winter exceedance flow
Flow Alternative Scenario 2 (MTTU 2000)	DS3 year round	MBF2 10% exceedance flow	MCD4 rate calculated for each site following the procedure depicted in Figure 3-2
Flow Alternative Scenario 3	DS2 12/15-3/31	MBF3 (June 2009) 0.8 ft mean regression line plus 3 standard errors	MCD1 rate 15% of 20% winter exceedance flow
Flow Alternative Scenario 4	DS1 10/1-3/31	MBF4 (June 2009) specified as a function of drainage area and mean annual flow	MCD2 rate 5% of 1.5 year flood magnitude
Flow Alternative Scenario 5 (NMFS-DFG 2002, MCD volume)	DS2 12/15-3/31	MBF1 February median daily flow	MCD3 volume 10% estimated unimpaired runoff
Flow Alternative Scenario 6 Draft Policy Regional Criteria	DS3 10/1-3/31	MBF3 (June 2009) 0.8 ft mean regression line plus 3 standard errors	MCD2 rate 5% of 1.5 year flood magnitude

² Table 4-2 is a revision of Table 4-2 in the Task 3 Report (R2, 2008).

³ These figures are revisions of figures of the same name in the Task 3 Report (R2, 2008).

Summary of Habitat Analysis Results

The results of the extended habitat analysis suggest that the Draft Policy regional criteria (Flow Alternative Scenario 6) result in similar passage and spawning habitat opportunities as Flow Alternative Scenarios 1 (DS1, MBF1, MCD1) and 3 (DS1, MBF3, MCD1) in most of the validation sites, improved in a few validation sites, and reduced in a few other validation sites. Overall, the Draft Policy regional criteria does not appear to adversely affect spawning habitat opportunities (compared with unimpaired conditions) more frequently than the Flow Alternative Scenarios 1 (DS1, MBF1, MCD1), 2 (DS2, MBF2, MCD4) and 5 (DS1, MBF1, MCD3). Spawning habitat availability is reduced in one validation site for steelhead and coho (Carneros Creek), and three sites for Chinook (Carneros, Dunn and Franz creeks). In the cases where passage opportunities are reduced compared with conditions associated with Flow Alternative Scenarios 1 (DS1, MBF1, MCD1) and 2 (DS2, MBF2, MCD4), the cause appears to reflect the higher MCD rate used by the Draft Policy (MCD2) as indicated by the similarity in results at some sites for Flow Alternative Scenario 4 (DS3, MBF4, MCD2) which also uses MCD2.

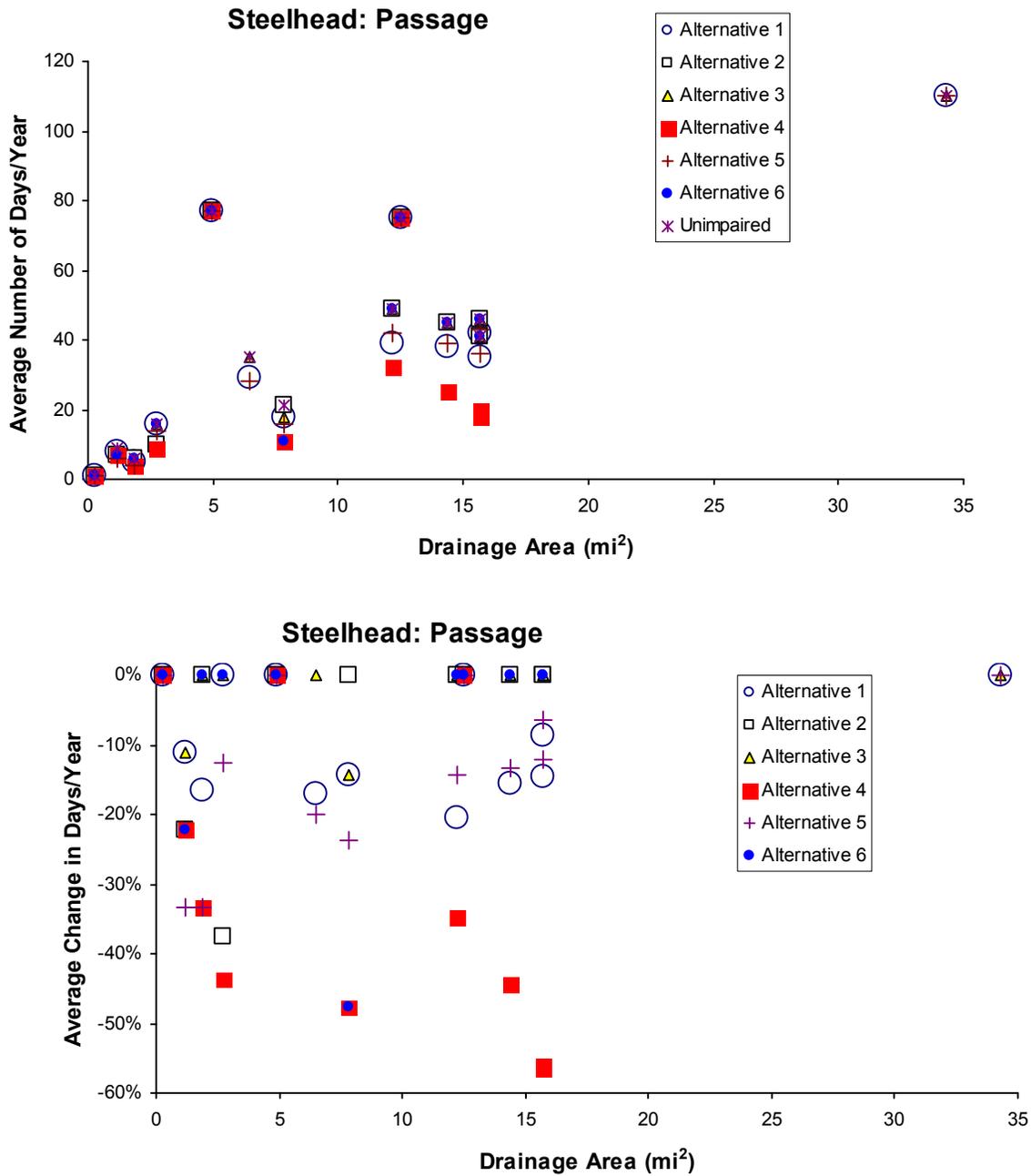


Figure 4-6. Predicted effects of the Flow Alternative Scenarios on upstream passage opportunities for steelhead trout in the validation sites, expressed as average number of days per year (top) and percent change from estimated unimpaired flow conditions (bottom), as a function of drainage area.

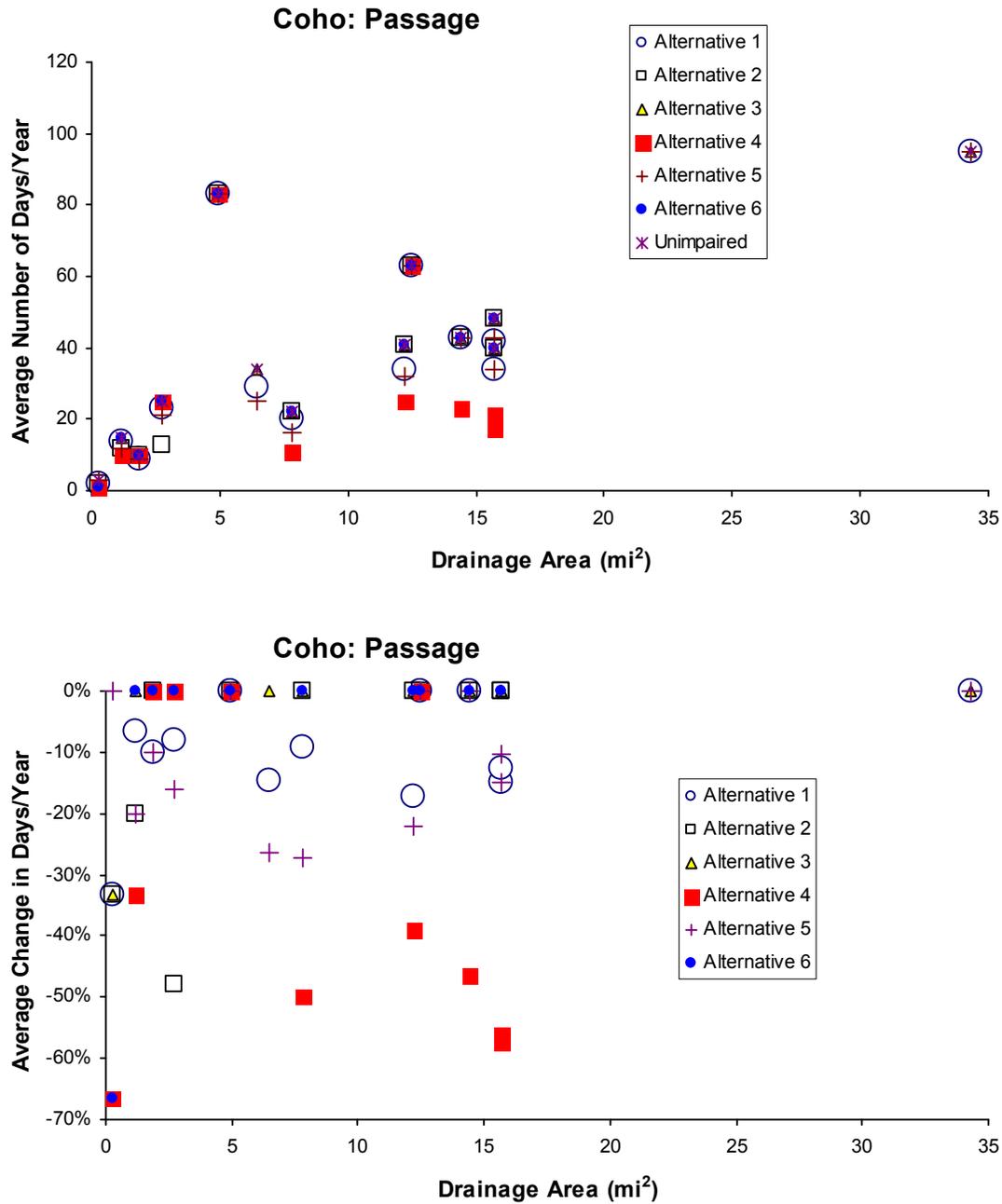


Figure 4-7. Predicted effects of the Flow Alternative Scenarios on upstream passage opportunities for coho salmon in the validation sites, expressed as average number of days per year (top) and percent change from estimated unimpaired flow conditions (bottom), as a function of drainage area.

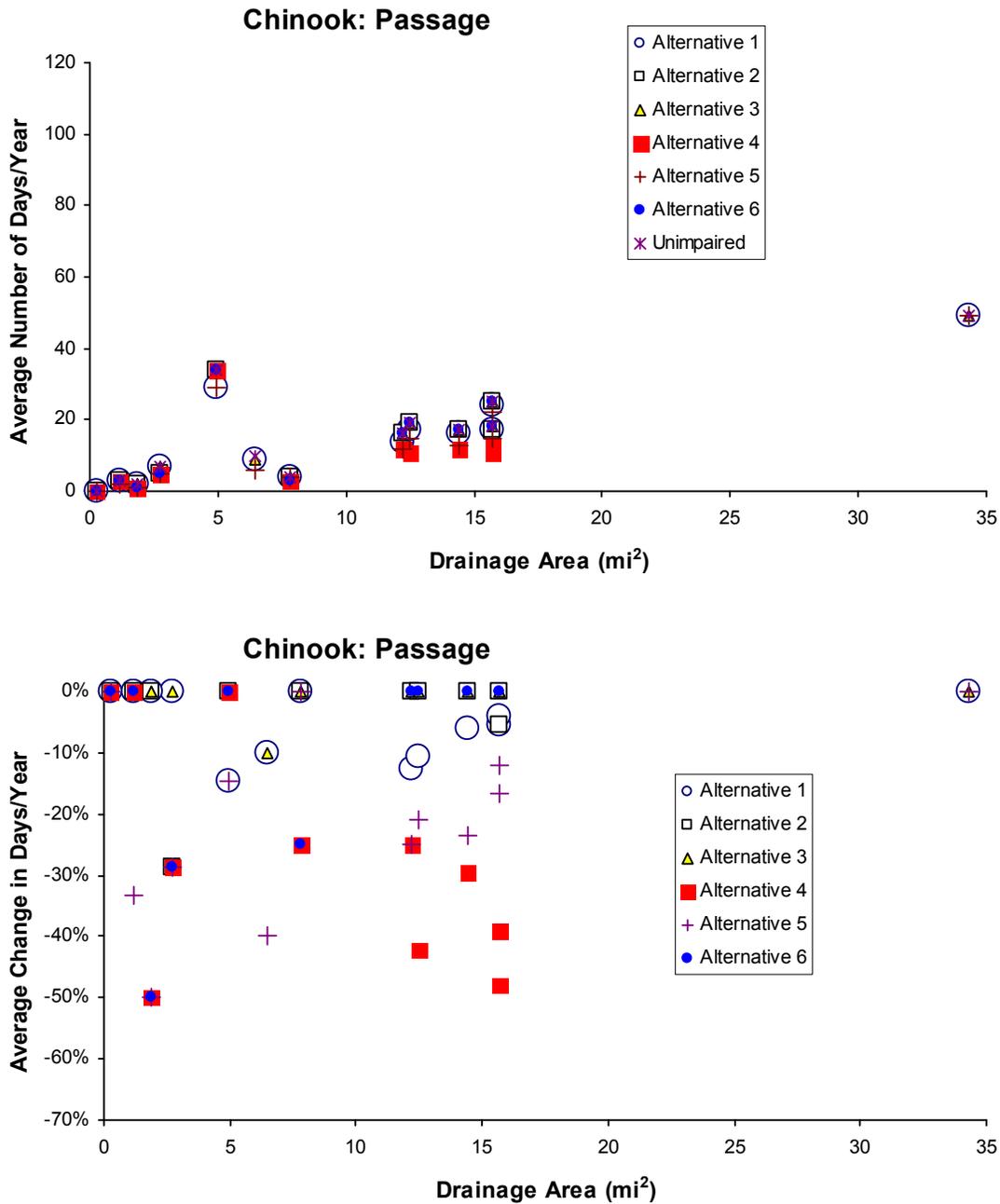


Figure 4-8. Predicted effects of the Flow Alternative Scenarios on upstream passage opportunities for Chinook salmon in the validation sites, expressed as average number of days per year (top) and percent change from estimated unimpaired flow conditions (bottom), as a function of drainage area.

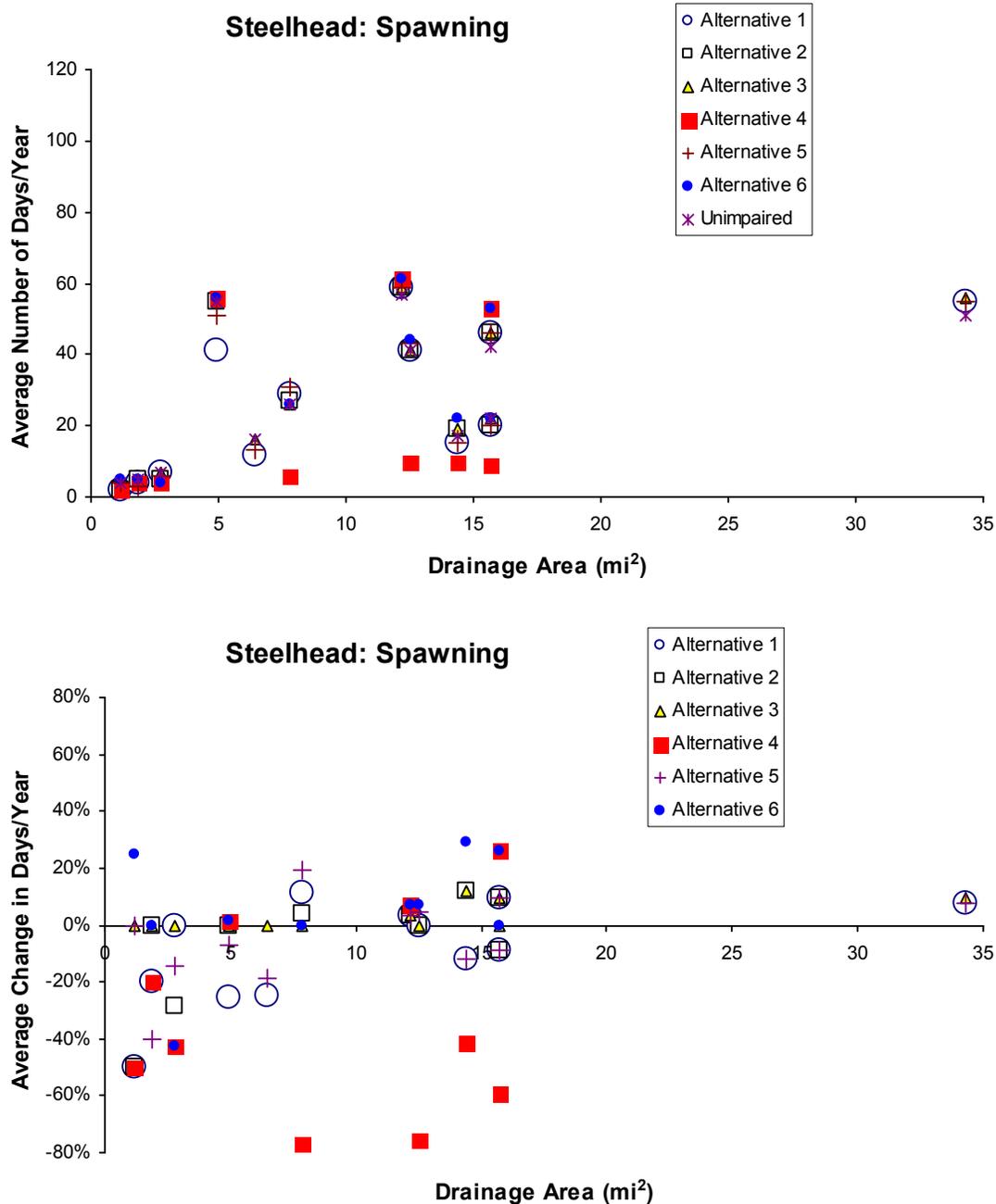


Figure 4-10. Predicted effects of the Flow Alternative Scenarios on spawning opportunities for steelhead trout in the validation sites, expressed as average number of days per year (top) and percent change from estimated unimpaired flow conditions (bottom). Data are plotted against each site's drainage area and are summarized from information presented in Appendix I.

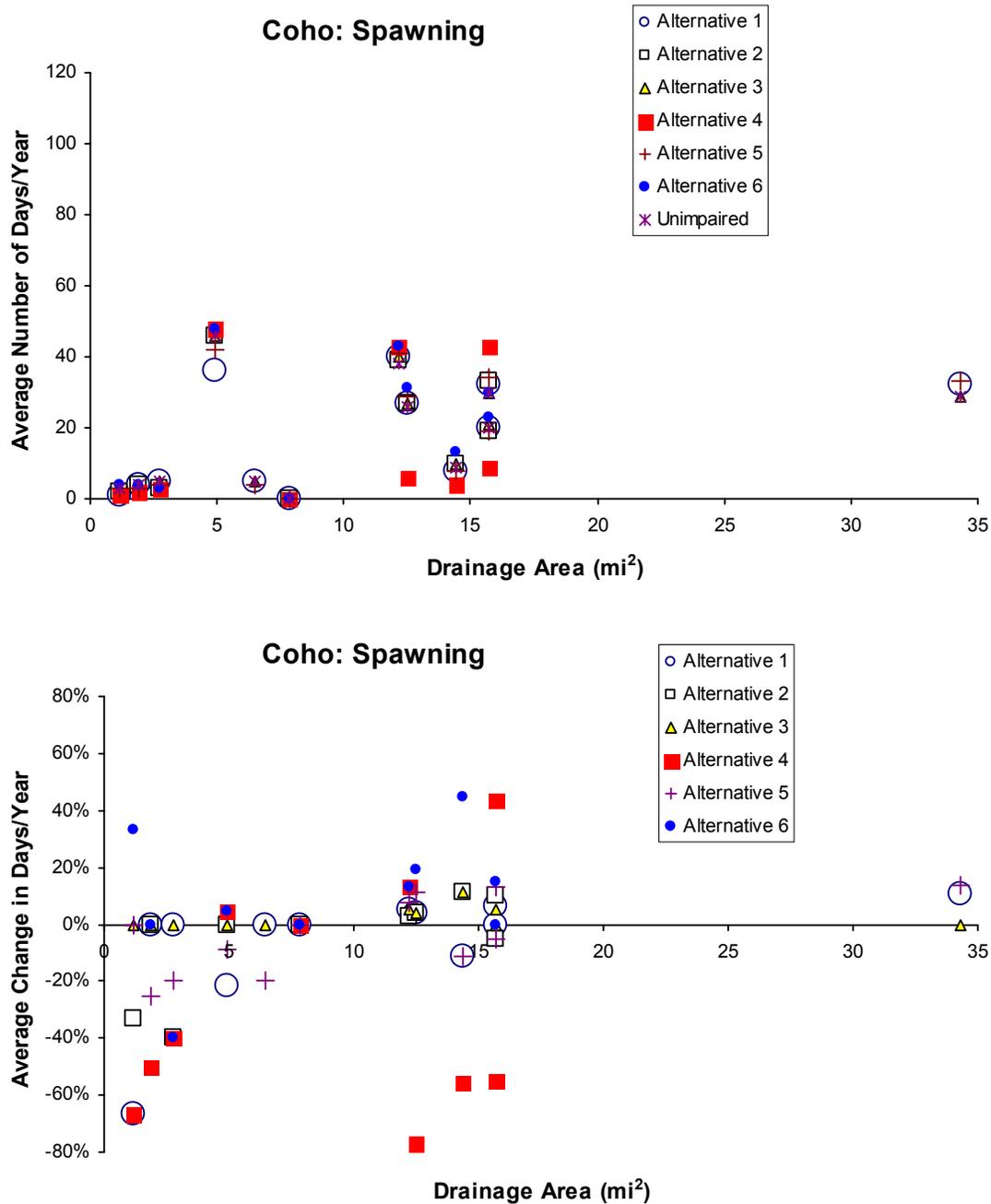


Figure 4-11. Predicted effects of the Flow Alternative Scenarios on spawning opportunities for coho salmon in the validation sites, expressed as average number of days per year (top) and percent change from estimated unimpaired flow conditions (bottom). Data are plotted against each site's drainage area and are summarized from information presented in Appendix I.

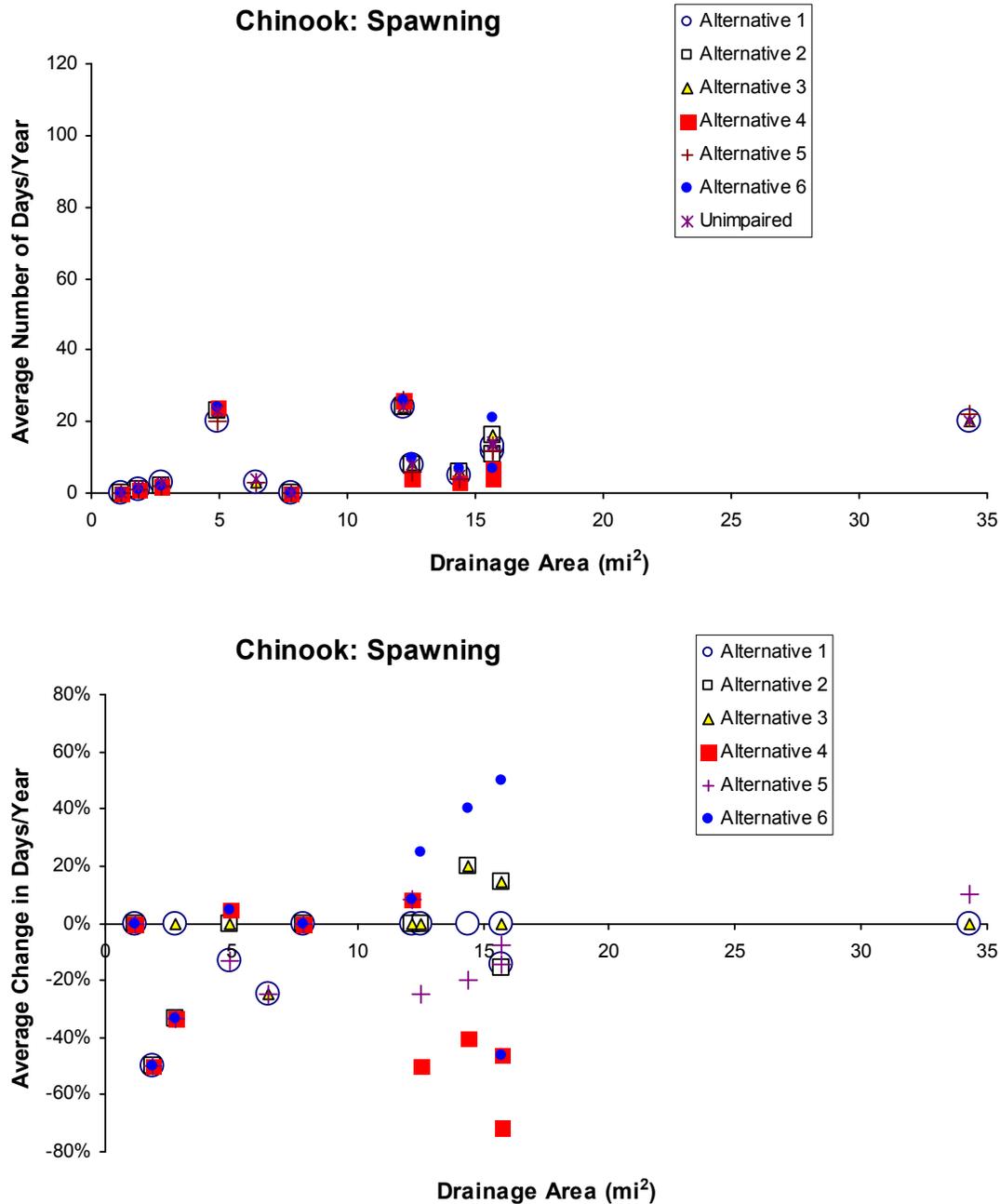


Figure 4-12. Predicted effects of the Flow Alternative Scenarios on spawning opportunities for Chinook salmon in the validation sites, expressed as average number of days per year (top) and percent change from estimated unimpaired flow conditions (bottom). Data are plotted against each site's drainage area and are summarized from information presented in Appendix I.

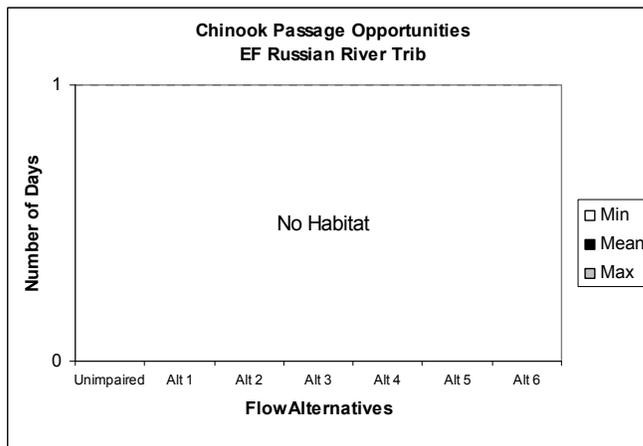
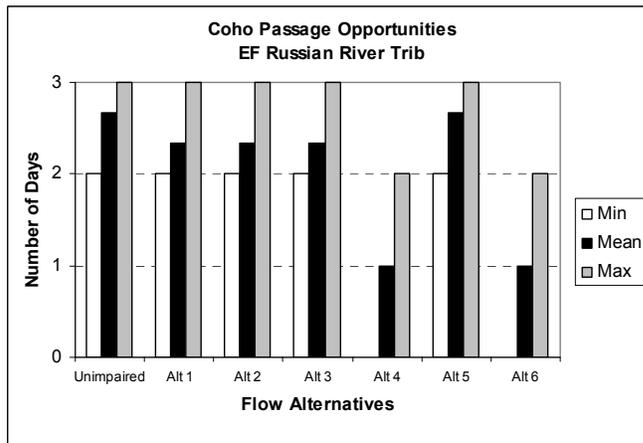
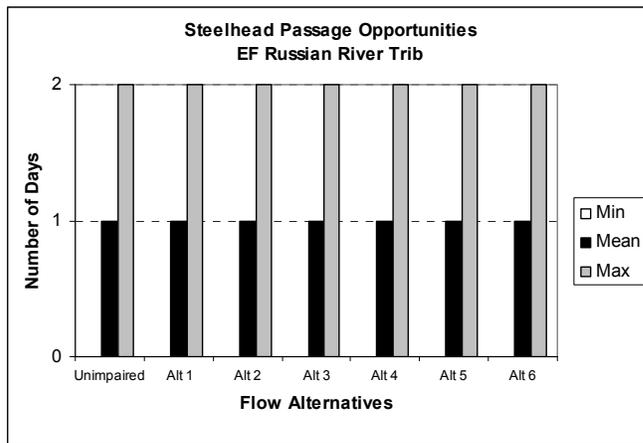


Figure I-1. Comparison of Flow Alternative Scenarios and unimpaired flow conditions for upstream passage in the East Fork Russian River Tributary validation site (drainage area = 0.25 mi²), expressed as number of days per water year. Minimum, mean, and maximum values are evaluated for each species' passage periods, for the period of record at a nearby USGS stream gage. Spawning opportunities were not assessed.

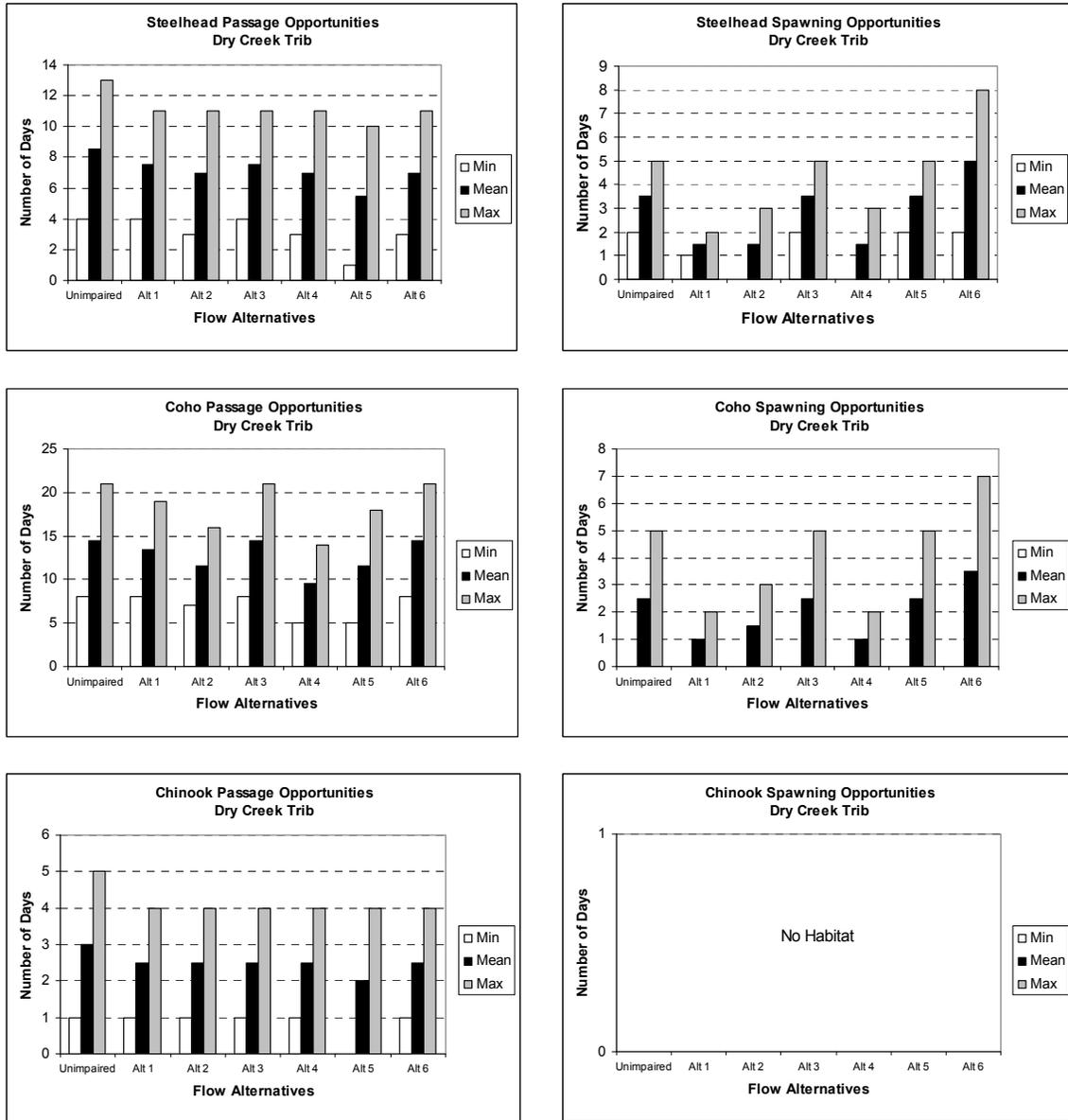


Figure I-2. Comparison of Flow Alternative Scenarios and unimpaired flow conditions for upstream passage and spawning in the Dry Creek Tributary validation site (drainage area = 1.19 mi²), expressed as number of days per water year. Minimum, mean, and maximum values are evaluated for each species' passage and spawning periods, for the period of record at a nearby USGS stream gage.

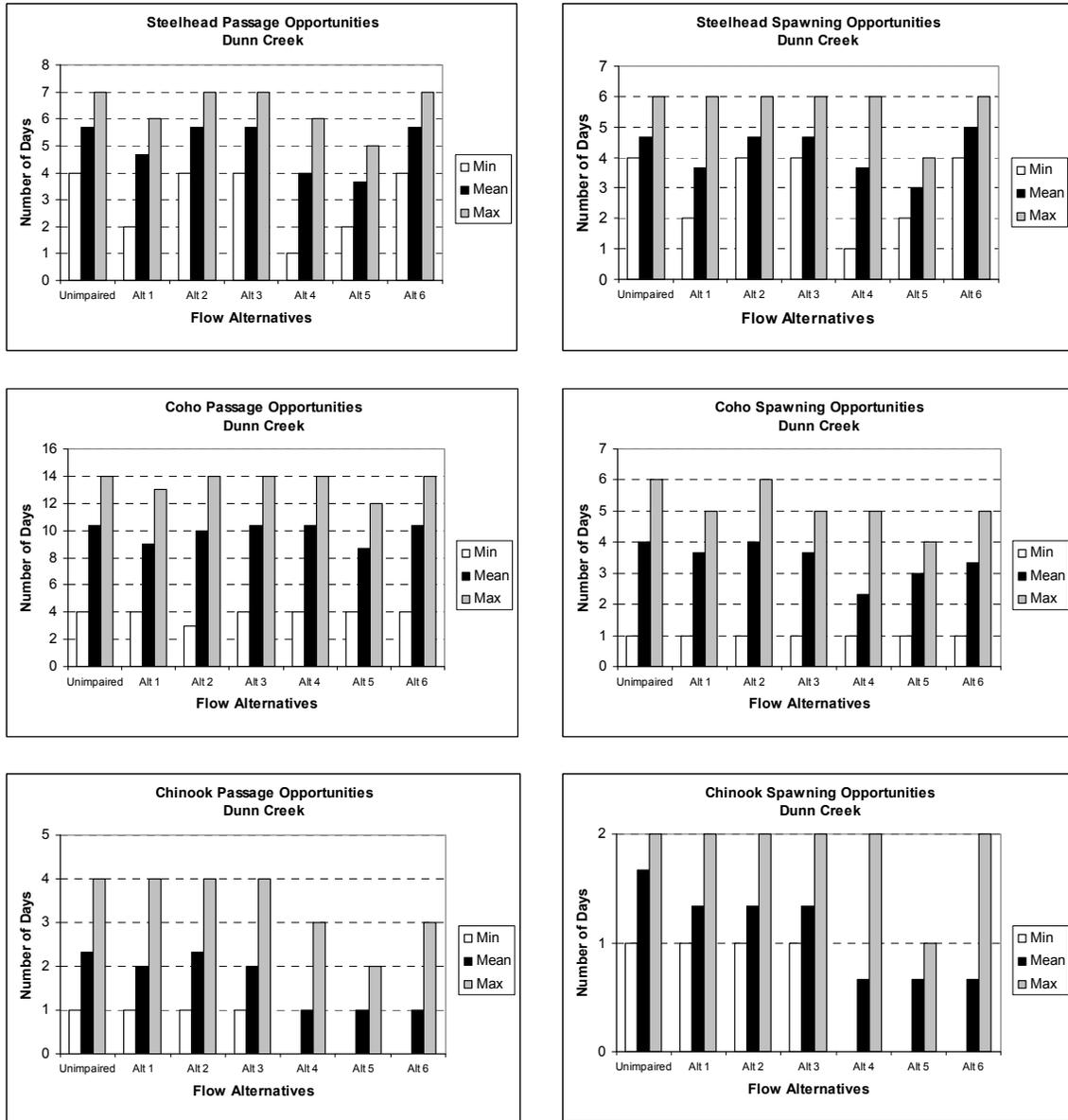


Figure I-3. Comparison of Flow Alternative Scenarios and unimpaired flow conditions for upstream passage and spawning in the Dunn Creek validation site (drainage area = 1.88 mi²), expressed as number of days per water year. Minimum, mean, and maximum values are evaluated for each species' passage and spawning periods, for the period of record at a nearby USGS stream gage.

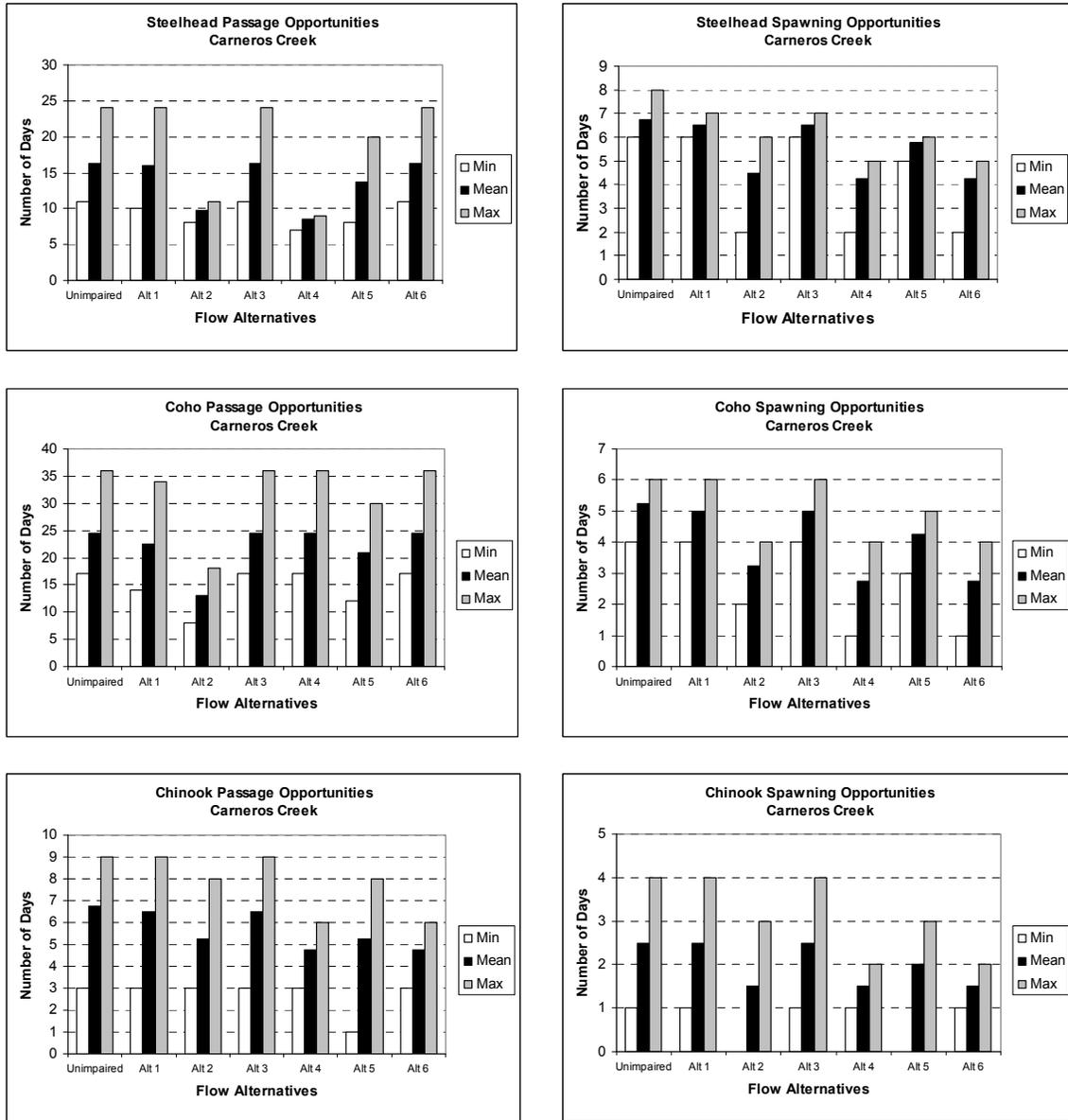


Figure I-4. Comparison of Flow Alternative Scenarios and unimpaired flow conditions for upstream passage and spawning in the Carneros Creek validation site (drainage area = 2.75 mi²), expressed as number of days per water year. Minimum, mean, and maximum values are evaluated for each species' passage and spawning periods, for the period of record at a nearby USGS stream gage.

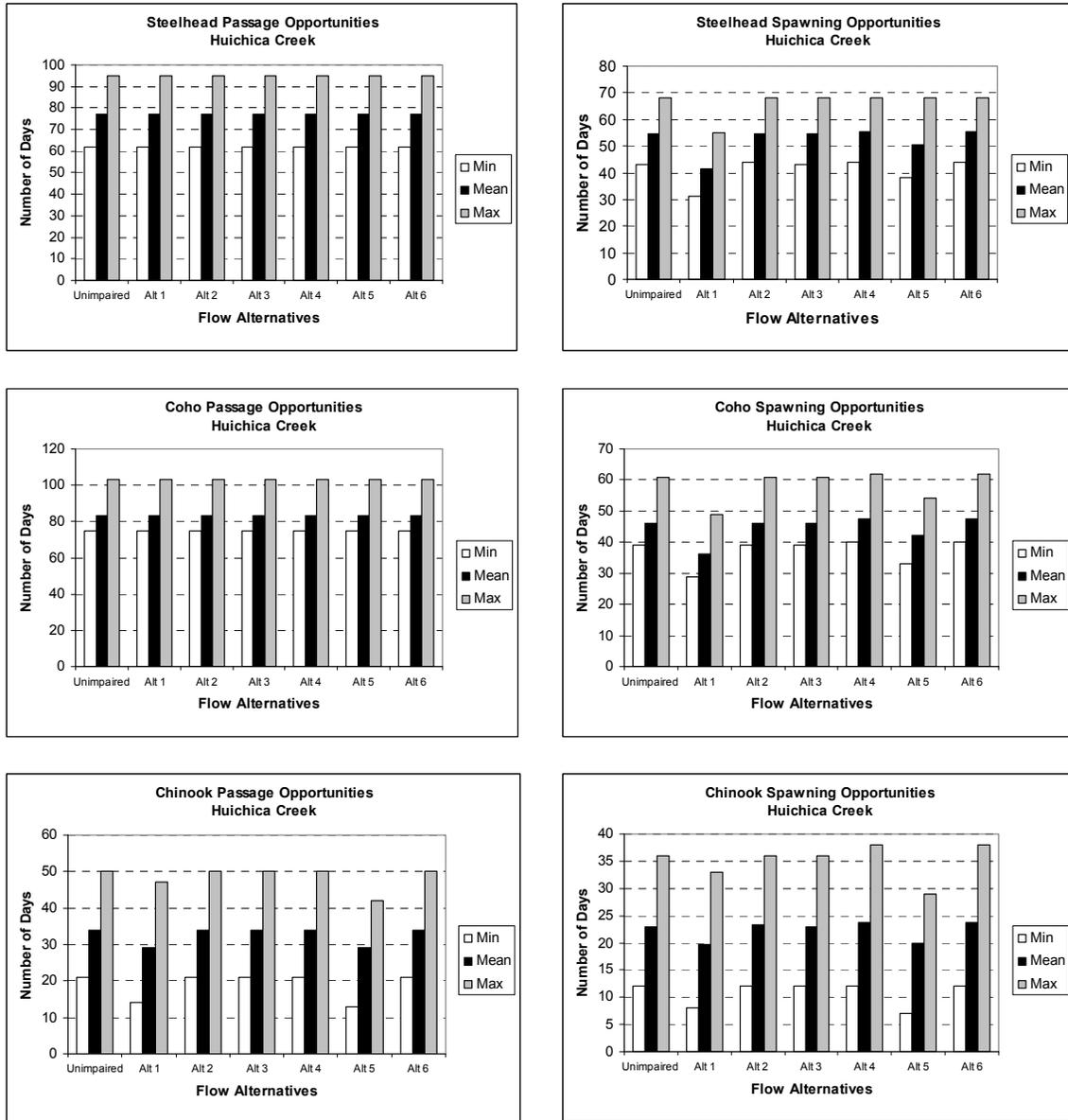


Figure I-5. Comparison of Flow Alternative Scenarios and unimpaired flow conditions for upstream passage and spawning in the Huichica Creek validation site (drainage area = 4.92 mi²), expressed as number of days per water year. Minimum, mean, and maximum values are evaluated for each species' passage and spawning periods, for the period of record at a nearby USGS stream gage.

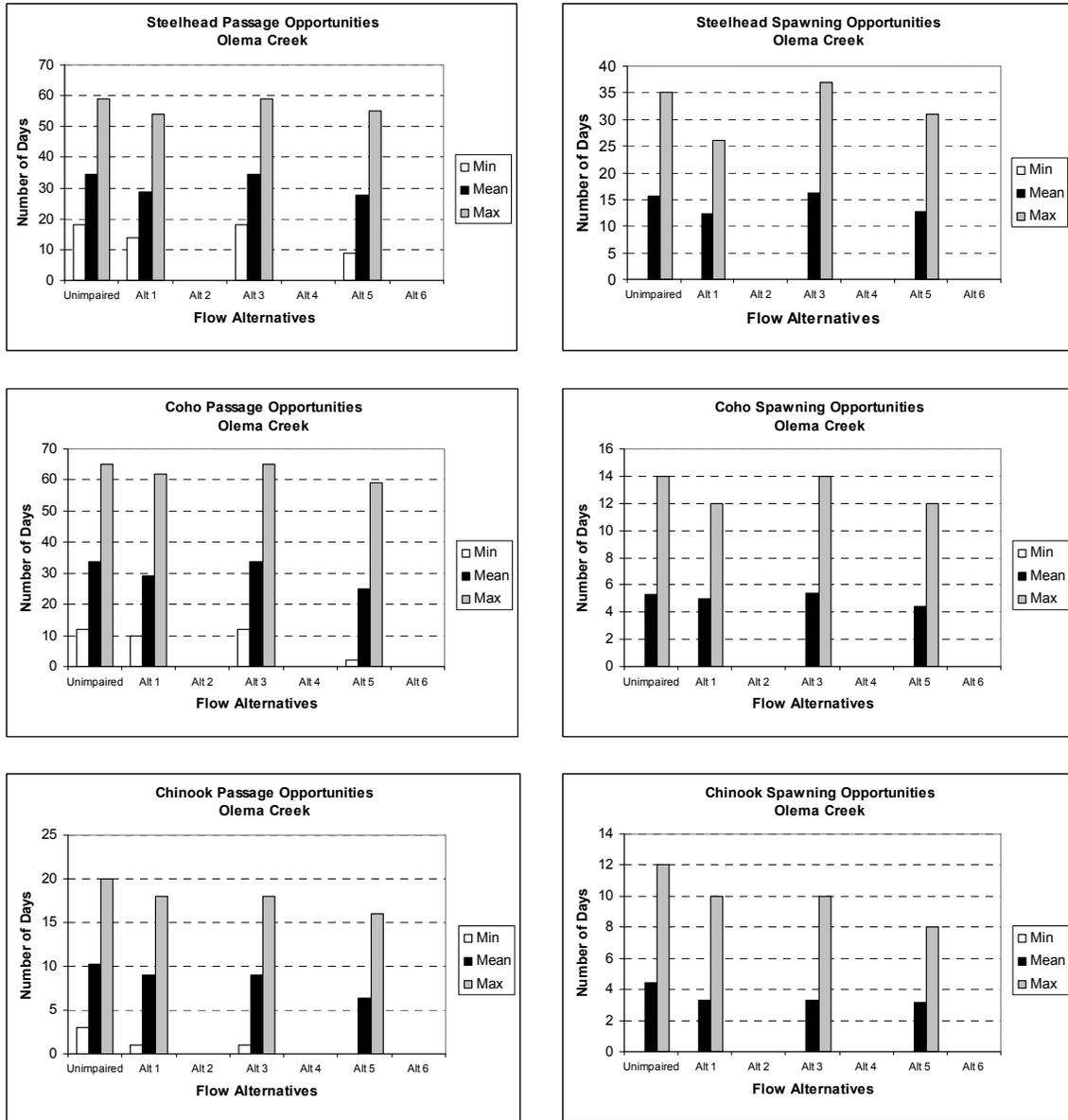


Figure I-6. Comparison of Flow Alternative Scenarios and unimpaired flow conditions for upstream passage and spawning in the Olema Creek validation site (drainage area = 6.47 mi²), expressed as number of days per water year. Minimum, mean, and maximum values are evaluated for each species' passage and spawning periods, for the period of record at a nearby USGS stream gage.

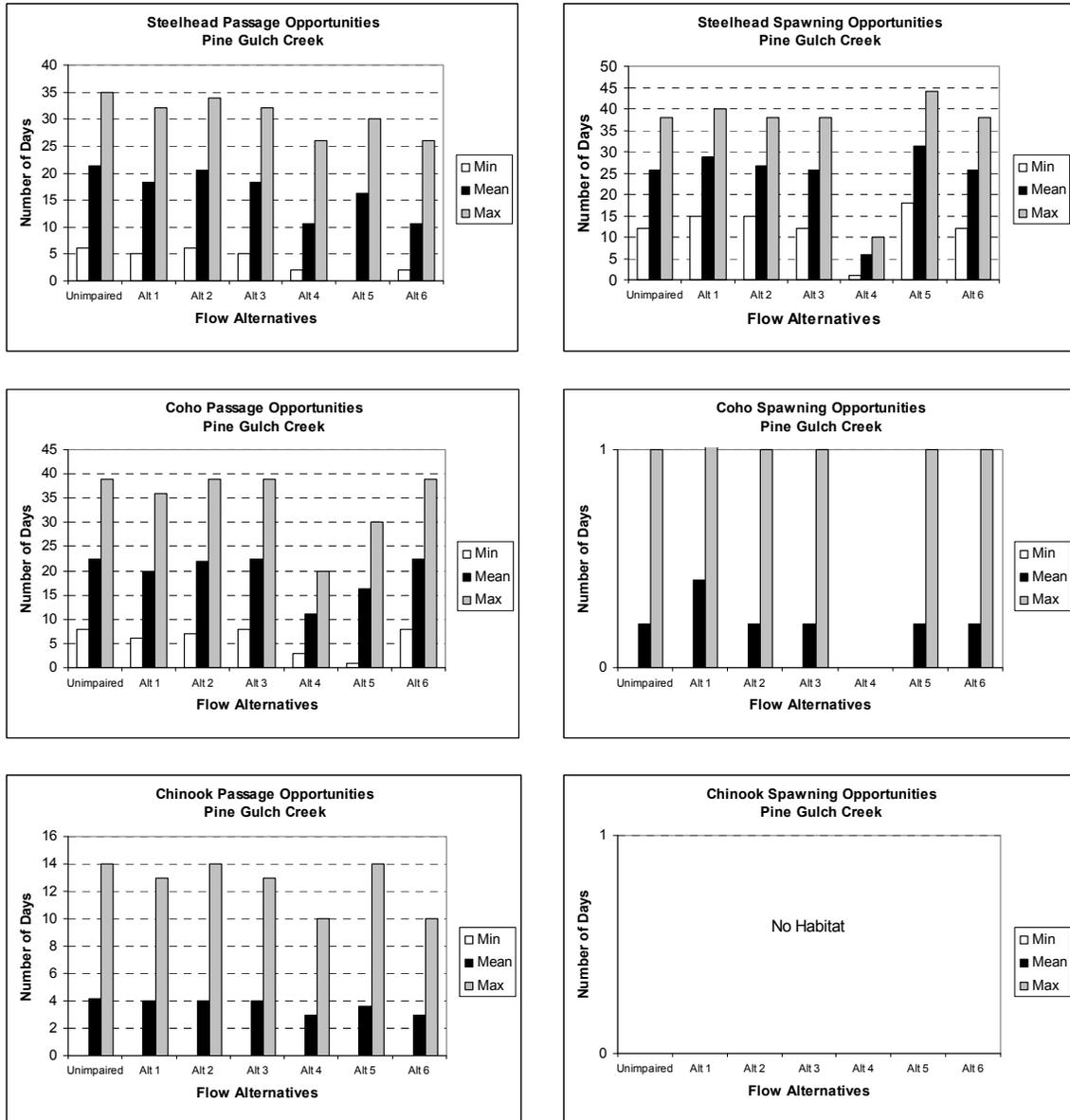


Figure I-7. Comparison of Flow Alternative Scenarios and unimpaired flow conditions for upstream passage and spawning in the Pine Gulch Creek validation site (drainage area = 7.83 mi²) expressed as number of days per water year. Minimum, mean, and maximum values are evaluated for each species' passage and spawning periods, for the period of record at a nearby USGS stream gage.

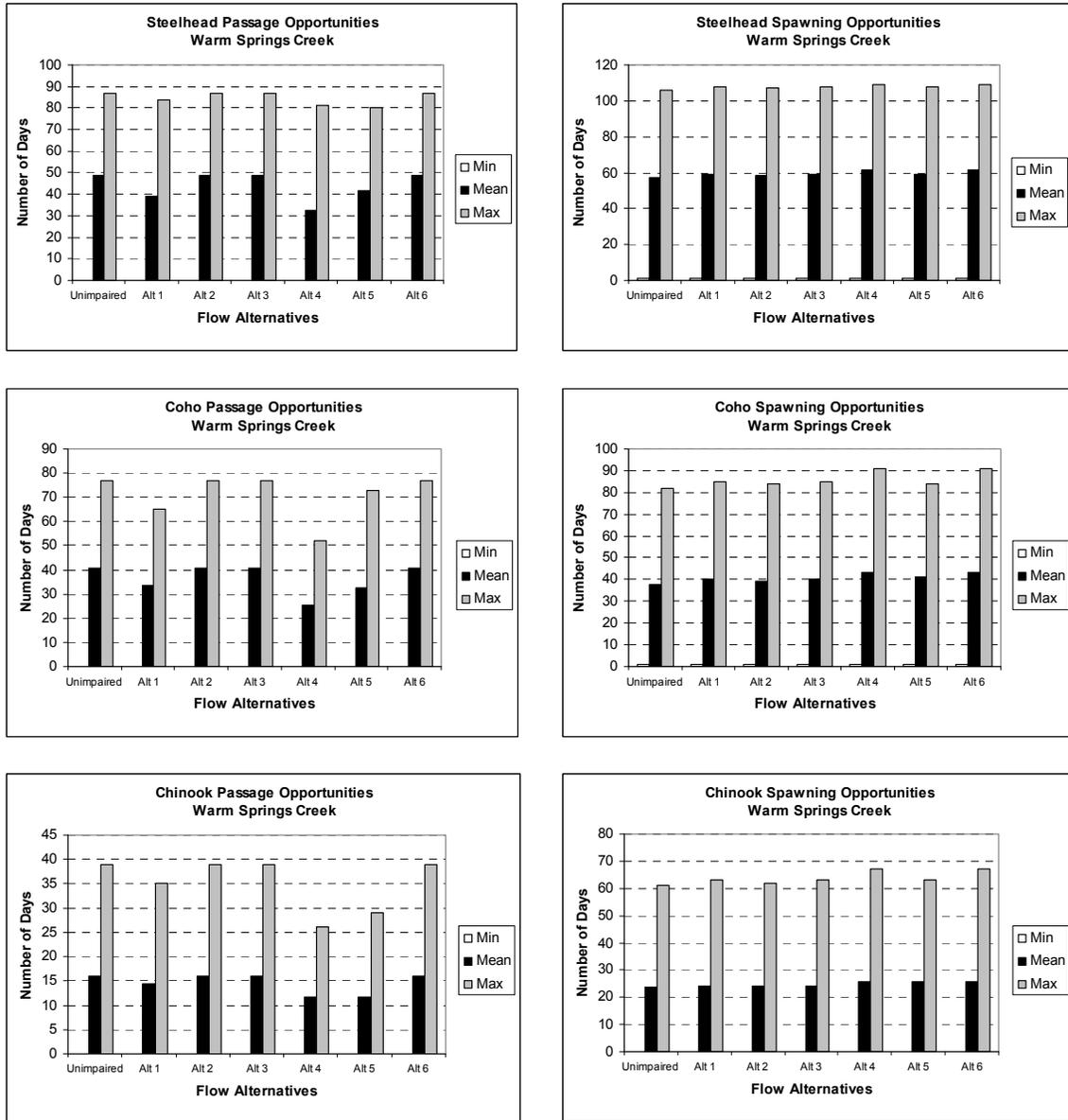


Figure I-8. Comparison of alternative Flow Alternative Scenarios and unimpaired flow conditions for upstream passage and spawning in the Warm Springs Creek validation site (drainage area = 12.2 mi²), expressed as number of days per water year. Minimum, mean, and maximum values are evaluated for each species' passage and spawning periods, for the period of record at a nearby USGS stream gage.

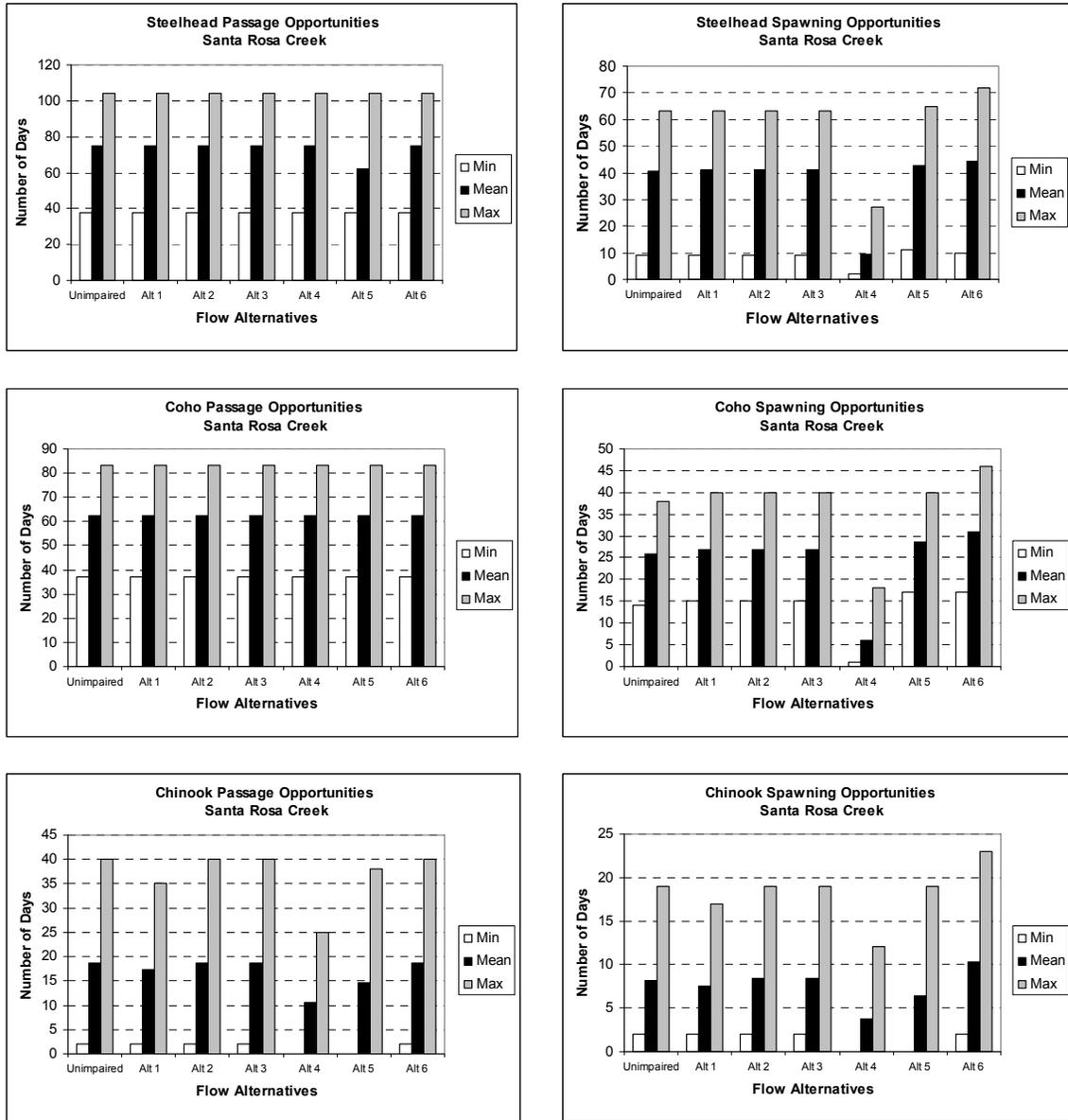


Figure I-9. Comparison of Flow Alternative Scenarios and unimpaired flow conditions for upstream passage and spawning in the Santa Rosa Creek validation site (drainage area = 12.5 mi²), expressed as number of days per water year. Minimum, mean, and maximum values are evaluated for each species' passage and spawning periods, for the period of record at a nearby USGS stream gage.

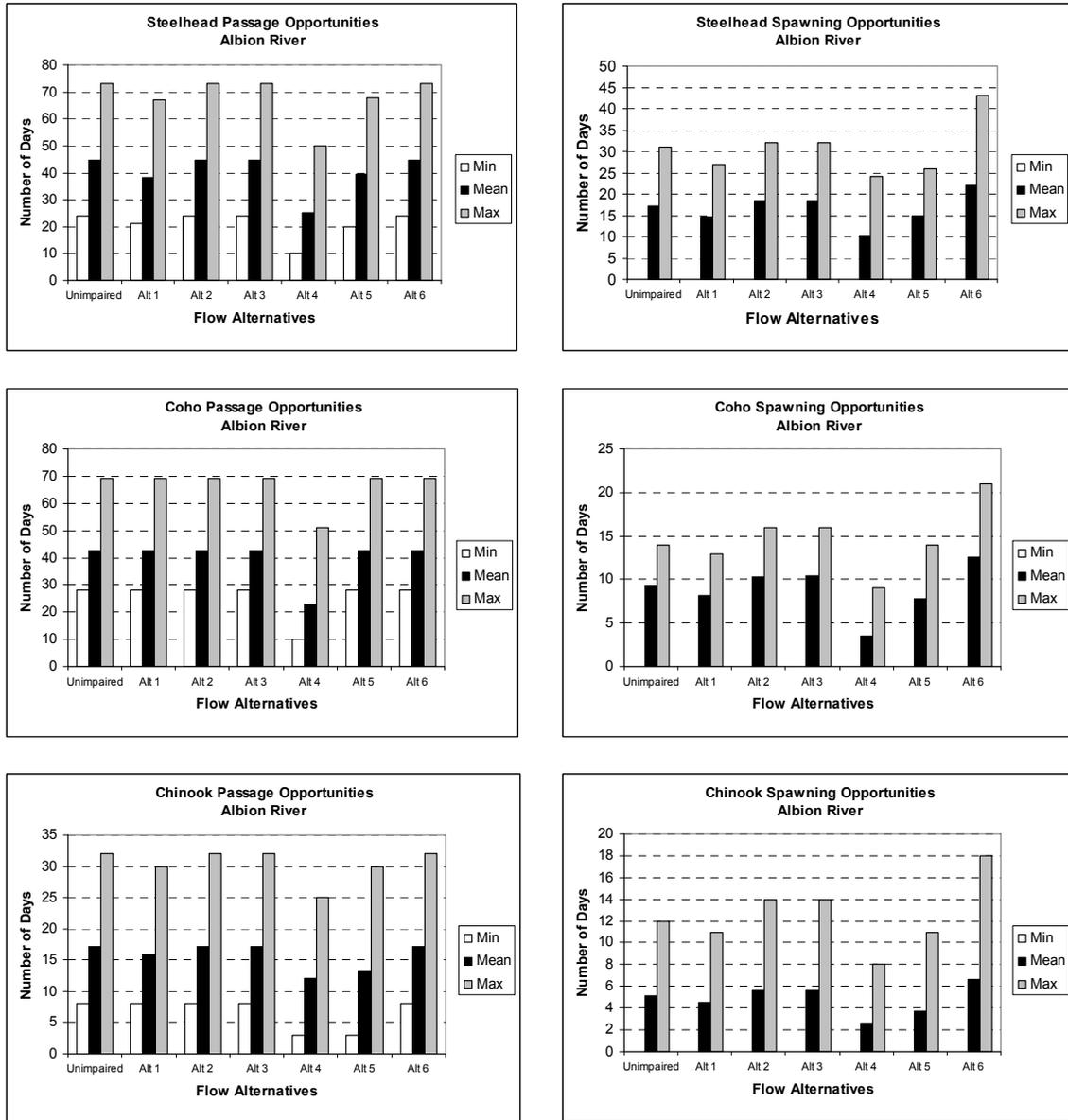


Figure I-10. Comparison of Flow Alternative Scenarios and unimpaired flow conditions for upstream passage and spawning in the Albion River validation site (drainage area = 14.4 mi²), expressed as number of days per water year. Minimum, mean, and maximum values are evaluated for each species' passage and spawning periods, for the period of record at a nearby USGS stream gage.

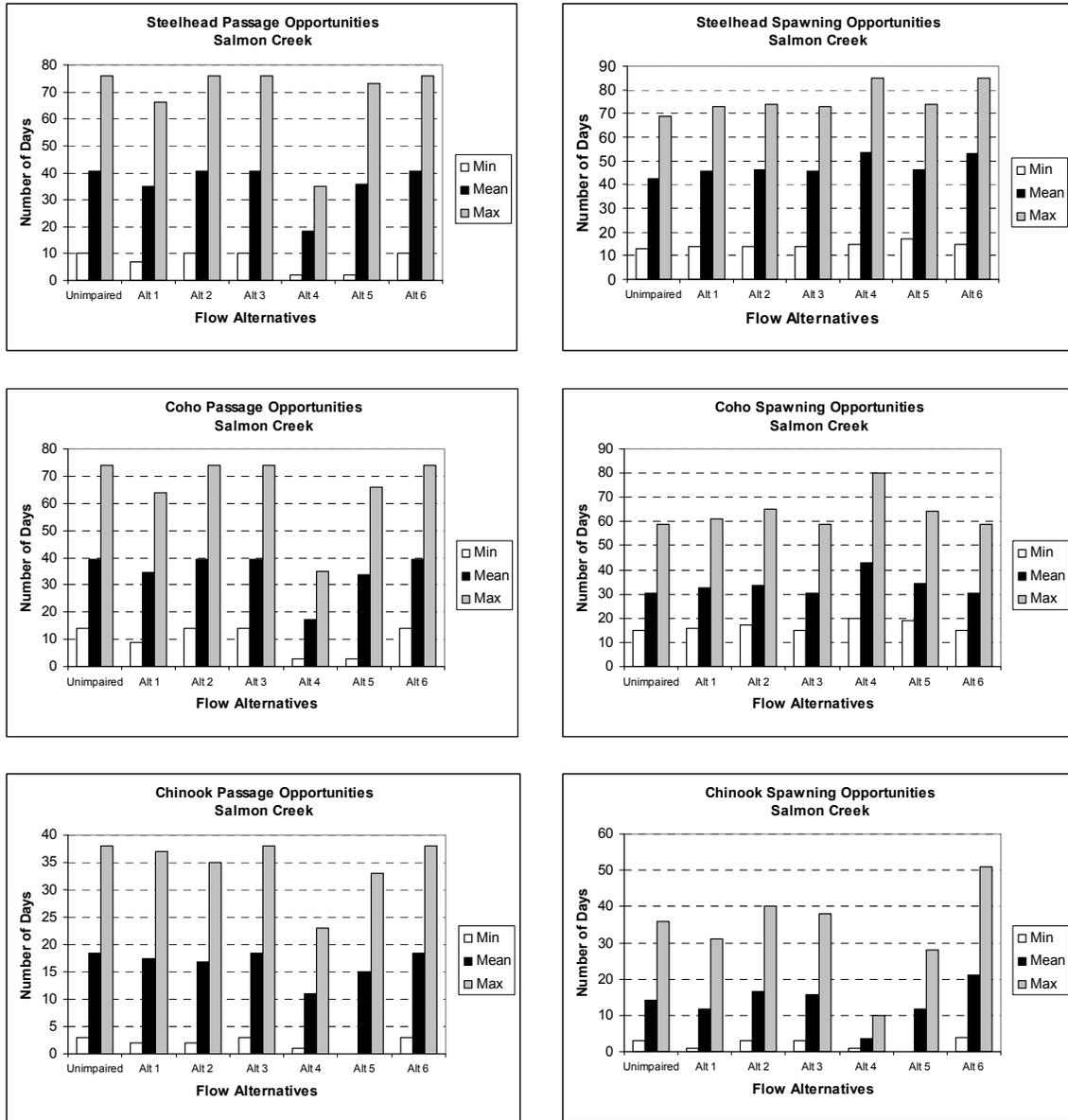


Figure I-11. Comparison of Flow Alternative Scenarios and unimpaired flow conditions for upstream passage and spawning in the Salmon Creek validation site (drainage area = 15.7 mi²), expressed as number of days per water year. Minimum, mean, and maximum values are evaluated for each species' passage and spawning periods, for the period of record at a nearby USGS stream gage.

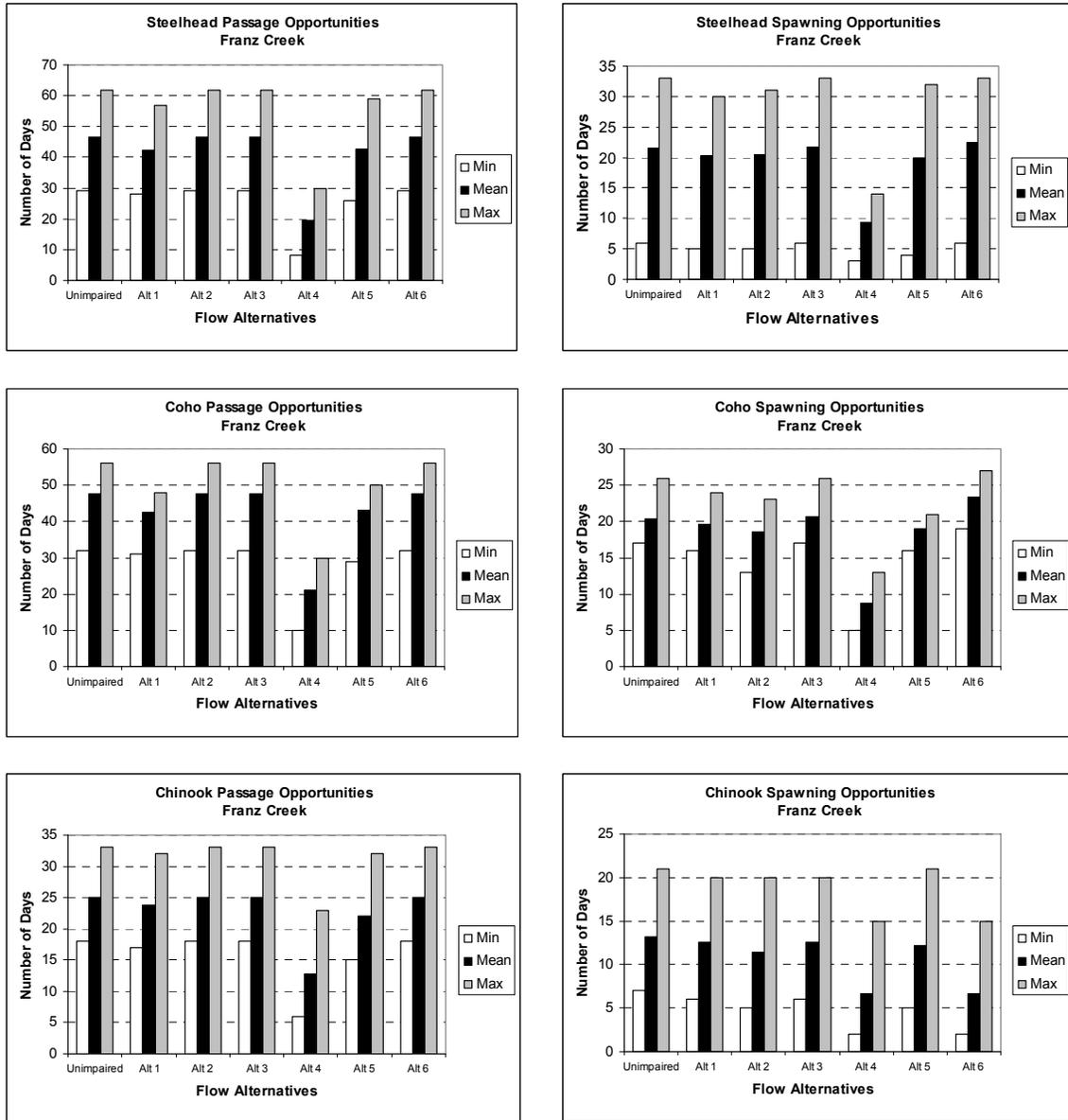


Figure I-12. Comparison of Flow Alternative Scenarios and unimpaired flow conditions for upstream passage and spawning in the Franz Creek validation site (drainage area = 15.7 mi²), expressed as number of days per water year. Minimum, mean, and maximum values are evaluated for each species' passage and spawning periods, for the period of record at a nearby USGS stream gage.

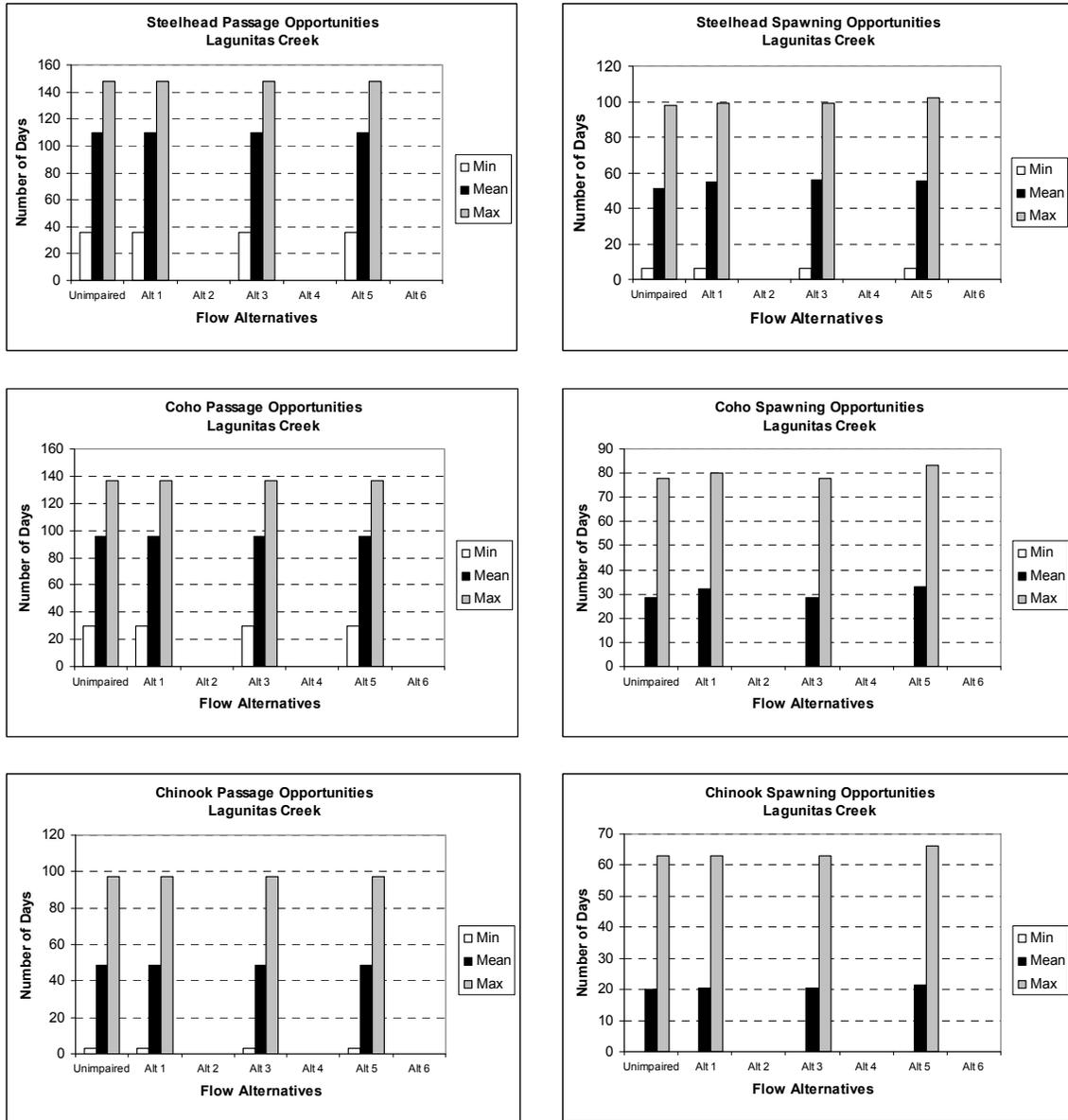


Figure I-13. Comparison of Flow Alternative Scenarios and unimpaired flow conditions for upstream passage and spawning in the Lagunitas Creek validation site (drainage area = 34.3 mi²), expressed as number of days per water year. Minimum, mean, and maximum values are evaluated between 10/1-3/31 over the period of record at a nearby USGS stream gage.