Fish Expert Review of Flow Sensitive Species Clustering

**No comments, but concur with results**

Jennifer Paretti, CDFW, SoCal

Rosi Dagit, Santa Monica RCD, SoCal

**No Response**

Sabrina Drill

Peter Moyle

Rob Titus (DFW)

Jason Nishijima (SC Valley Water District)

# Question 1

*Do the* ***fish species*** *within these assemblages and the* ***assemblage*** *(****cluster) boundaries*** *make sense from an ecological and management perspective?*

**Russell Barabe, CDFW, SoCal**

First, I am only reviewing the South Coast Assemblages from Santa Barbara south. The fish species within these assemblages do not make sense to me. Rainbow trout were excluded, yet are present within many drainages (San Gabriel River for example). Why exclude these native populations but include steelhead? With current conditions heavily impacted by drought, we are seeing impacts to these populations. Southern tidewater goby are included in the drainages associated with Camp Pendleton, which makes sense, but all other areas list northern tidewater goby. It is highly unlikely that northern tidewater goby made it around Point Conception. Although this does not make much difference in the clusters, it is an important distinction. From a management perspective, the cluster boundaries make sense.

**Camm Swift, LA Museum of Natural History**

* Monterey Bay is included in the southern coastal whereas faunally it would seem to be more closely related to the Central Valley.
* The colors of the maps show divisions but the streams from the Los Angeles Basin south to the Mexican border are colored the same with the dark maroon, essentially Camp Pendleton in between, perhaps solely because of the southern tidewater goby presence there (only).  However, faunally the L. A. Basin is distinctive with 7-8 freshwater inhabiting species and the streams for some distance to the north and south have significantly fewer and could be grouped together separate from those on the L. A. Basin.

**Tom Taylor, ESA**

Not always, I did a random check on how well the fish species relate to the cluster boundaries and how the cluster boundaries are defined.  In most cases both the fish species and the boundaries make pretty good sense, but there were some examples where the boundaries were oddly organized or combined and resulted in not identifying Flow Sensitive species that I know are present.  In some cases clusters have species assigned that would not occur in them.

 In the Lake Tahoe basin, three or four fish species (Lahontan cutthroat trout, Lahontan mountain sucker, Lahontan speckled dace, Mountain whitefish) are listed for every cluster, but in reality there are major differences in species use between the clusters mostly based on watershed size.   With few exceptions, only the larger systems (Upper Truckee River, Taylor Creek, Trout Creek) consistently support Mountain whitefish and Lahontan mountain suckers. Most of the other smaller streams would support Lahontan speckled dace, but not the other three species and many of those streams would only support native species in Lake Tahoe frontage habitats with the upstream portions within these clusters containing non-native salmonids.

Also the Upper Truckee River is divided into two clusters, with the same suite of species in each cluster.  In reality the upstream cluster has only a subset of what is found in the downstream cluster.    Also within the Tahoe Basin, in many of the smaller streams there are not many options to manage flows in these watersheds - they are few dams and/or water diversions that would affect natural flows, so the need to cluster these sites for the purpose of your paper seems to be called into question (see my comment under item 2 below).

American River discrepancies in Fish Assemblage.  The Upper American River includes the river between Sunrise Blvd and Nimbus Dam - and upstream of Nimbus Dam to Folsom Dam - this is an odd break and doesn't make good sense ecologically because this cluster should include fall and late-fall salmon, steelhead and tule perch in the species assemblage, at least for the anadromous portion of the river.  I would recommend taking the Lower American River Cluster all the way to Nimbus Dam.  I don't see any reason, ecologically or otherwise to break the Lower American River into two clusters.  The river below Nimbus is recognized as the Lower American River. The Lower American River species assemblage should not include Southern green sturgeon or Central Valley winter Chinook salmon

Arcade Creek Fish Assemblage.  This is a small highly urbanized stream that often goes mostly dry during summer.  It would not be conducive to tule perch or riffle sculpin but the other species are possible. Recent surveys have documented fall-run Chinook using the stream when sufficient fall hydrology occurs.

**Larry Brown**

I would say these clusters look pretty good for general purposes but some of the details seem off. Several of the issues are related to translocations. I think that if you want outside experts to accept these groupings you need to track down the reasons some of these anomalies occur. It is also important to note that it is unlikely managers will want to pursue management strategies that favor undesired translocated species, even translocated native species. Probably the best example is Sacramento Pikeminnow in the Eel River. Some specific examples of things that caught my eye (I’m sure there are others).

The Table in Appendix B was problematic in several ways

* The Methods say the analysis was done at the species level; however, there are 3 “species” of California Roach listed in the Table: California Roach, Northern Roach, and Roach. The taxonomy of California Roach is currently in flux but it would be nice to know what is being used here. Maybe this derives a mention in Methods or in a footnote to the Table.
* Another thing to think about when considering species vs. subspecies is whether these designations based on genetics are significant in terms of the ecology (and flow needs) of the fish. In the case of roach, I would guess their life histories and flow needs are pretty similar across their range. On the other hand, flow needs of different races of salmon can be pretty similar
* I was unclear about the “Pacific Lamprey or Goose Lake Lamprey”. I think taxonomically the GLL is a landlocked PL? Since I’m not quite sure how these 2 species were treated so I’m not sure how that would affect the analysis.
* Is “Sucker” supposed to indicate “Sacramento Sucker”? Use official AFS Common Names to reduce confusion
* The speckled dace example in the Great Basin is a really interesting an example of where management might conflict with clusters. The dace in the disjunct northern areas are designated as Sacramento Speckled Dace. If these populations are the result of translocations should water users be required to support an invasive species? You don’t have to answer the question but managers need to be aware of situations like this.
* Coastal group 2 is listed as having Longfin Smelt but that species is not in the list associated with the map. You need to cross-check the Table and the map.
* The listing of Pikeminnow in Coastal Group 7 is due to the introduced population in the Eel River. I think this deserves mention.

# Question 2

*Do the* ***number of assemblages*** *for each region make sense from a species and management perspective? Should there be more or less assemblages in a given region?*

**Russell Barabe, CDFW, SoCal**

Looks good.

**Larry Brown**

More detail is always nice but I don’t think I would go a finer resolution at this point. Since this work is meant to apply to Tier 1 I think we want to be at roughly the same spatial scale as the stream types and I think you are in that ballpark now.

Tom and Camm talked about this question but didn’t answer it directly (see end of document).

# Question 3

*Are any species missing from a given assemblage?*

**Russell Barabe, CDFW, SoCal**

Yes. Rainbow trout are present within several of these drainages, and were determined to be native by Dr. Garza. The life history of this species illustrates the importance of flow to this species, yet it is excluded from this analysis. Why?

**Camm Swift, LA Museum of Natural History**

* It did not seem that the suckers were utilized in the coastal areas of occurrence like tribs to Tomales Bay.
* While Lahontan trout are considered it could be argued that the Mohave chub which still occurs in the Mohave R. drainage and is critically endangered should also be considered.  Lahontan trout occur with suckers, minnows and possibly a sculpin in the greater Truckee River system including Lake Tahoe.

**Brett Harvey, Humboldt State**

Speckled dace from North Coast clusters 3 & 6

**Tom Taylor, ESA**

Paiute sculpin (Cottus beldingi), Tahoe sucker (Catostomus tahoensis) and Lahontan redside (Richarsonius egregious) are missing from the Great Basin Assemblage.  Rainbow trout are not identified specifically in the Central Valley Assemblage (with the exception of the Kern Rainbow).

**Larry Brown**

Nothing leaped out at me as missing.

# Question 4

*Are there any flow-sensitive fish species that were not included in the flow-sensitive list? (See Appendix A)*

**Russell Barabe, CDFW, SoCal**

Yes, see comment above.

**Camm Swift, LA Museum of Natural History**

* In Appendix A I was curious why fully armored, anadromous stickleback were not included. Perhaps this is why just stickleback without additional designation is given in the groupings. They occur over most of the state and enter streams to breed.
* It was surprising to see that *Cottus asper* and *Cottus aleuticus* are not included particularly since the former seems catadromous in several streams and both species are found in virtually all coastal streams from central California northward.
* You recognize the tule perch subspecies in the Central Valley but have not included the Russian subspecies for coastal streams apparently?
* I made a note earlier that Fundulus parvipinnis was mispelled but did not see it in the more recent account.  If it was to be included a few other estuarine things that run up into freshwater streams as juveniles could be added like staghorn sculpin, starry flounder, or striped mullet or enter freshwater streams to spawn like Pacific herring and a few osmerids.

**Tom Taylor, ESA**

* Paiute sculpin (Cottus beldingi), Tahoe sucker (Catostomus tahoensis) and Lahontan redside (Richarsonius egregius)
* Clear Lake hitch (Lavinia excilicauda chi) is not included in Appendix A while the Sacramento and Monterey sub species are included. This is inconsistent, either include all sub species or lump them all under "hitch", and do the same for the other subspecies in a consistent manner.  Also steelhead/rainbow trout are not included in this Appendix.

**Larry Brown**

I did not review the original paper but I didn’t see any glaring omissions.

# Additional Comments:

## PISCES/data-related

**Camm Swift, LA Museum of Natural History**

* The methods indicate historical ranges are not considered but several in southern California seem to include fish that have been extirpated in some of the areas for a long time.
* Perhaps following the NMFS/USFWS Steelhead oversight boundaries, you left out the upper Cuyama and Santa Ynez rivers above dams where some native fish still occur even if anadromous fish no longer have access.
* When utilizing the web map I was surprised when clicking on, for example, the Big Tujunga Wash area of the Los Angeles River Basin, the middle Aliso Creek section of the Santa Ana River, and the East Fork of the San Gabriel River that almost the whole suite of native species came up on the list (except the extinct brook lamprey) both historical and current.  The stickleback and lampreys are long gone from these areas and the tidewater goby is restricted to the coastal mile or so of these drainages and only historically.  You list the northern tidewater goby for the Los Angeles River whereas it drains to San Pedro (L. A. harbor), south of Pt. Conception and thus the territory of the southern tidewater goby.  Recognizing historical records that show this river actually sometimes flowed west into the Ballona Valley and marsh which would have been northern tidewater goby.   In any case maybe these subdiviisons of the drainages are to be refined at some point but to the uninitiated they imply many more species than actually occur and some that are inappropriate for that inland section.

**Tom Taylor, ESA**

In the Clear Lake Basin, there are issues with the assemblages assigned to clusters associated with Manning, Adobe, Kelsey, Cole and Seigler Canyon Creek, along the western side of Clear Lake.  The largest of these watersheds, Kelsey Creek has the smallest species assemblage. None of these assemblage lists California roach, one of the more ubiquitous species in the Clear Lake Basin, and hitch are not included in any of these streams.  And the Thurston Lake Basin (HUC 12 ID CLOSED BASIN) also lists Sacramento sucker and Western Brook lamprey, when in reality it should not list any flow-dependent species.  This may be a problem with the way the Clear Lake Basin has been structured - only 5 species total are listed for the HUC 12 ID 180201160602.  It did not seem like the species assemblages was working well for most of the Clear Lake Basin tributaries.

## Web Map

**Camm Swift, LA Museum of Natural History**

* It would seem important to make it easier to see what group is defined by each combination of fishes by having them come up when the subareas are clicked on the map, or perhaps naming the groups somehow on the map.  Or maybe they are not actually specific to any place on the map but theoretical associations that might occur.  But it is confusing to have all species come up when clicking on the map as noted above.

## Other Comments

**Camm Swift, LA Museum of Natural History**

* In a couple of places Siphateles was spelled with an "a" before the L.

**Tom Taylor, ESA**

Managing flow-related issues is most relevant to stream segments affected by impoundments (dams and reservoirs) by direct diversions or pumping of underflow.  These kinds of activities usually occur some distance downstream of the headwater streams where there is sufficient capacity build a storage reservoir, or where sufficient flow exists to construct hydropower dams/diversions.  Direct Diversion and pumping of underflow typically occurs even lower down where river valleys widen out and where there is sufficient soil development and room for agricultural land or urbanization to establish.  Consequently, flows in the upper reaches of stream systems may not be directly affected by diversion or storage projects, however their fish populations may be affected by loss of access from downstream water development.  This brings up the issue of the number of cluster boundaries in your stream networks.  Can you effectively manage to the level of detail you have in the headwater areas or could you combine some of these clusters to reduce the detail without losing any management options?   For instance, in your example (Figure 3), are the species dominance differences in your example really significant - it's the same suite of species with different dominance between the clusters.  But are these differences really important - are they habitat-based and would they persist over time or do you think the dominance differences would fluctuate over time?  What would be the various options to manage these clusters?  Would it differ between the clusters or be pretty much the same for them?  In other words, is the cluster detail too fine for the management actions that could be applied.  Could the upstream headwater clusters be combined into larger cluster groups without losing management options?

**Brett Harvey, Humboldt State**

The species identified and clusters delineated could be fine, but I don’t have a basis for saying various alternatives would be equally good or better. I don’t know the specifics of the methods following assemblage and cluster identification, but surely it would be a good idea to include analysis of the sensitivity of the method to assemblage composition and geographic delineations. I think it would also be important to show how the method is superior to a combination of general guidance from Tier 1 followed by rapid site-specific analysis at Tier 2. I’m not getting that now because I can’t yet picture how use of the assemblages and clusters will alter basic conclusions from Tier 1 and more importantly how often someone with site-specific knowledge would conclude that the approach reaches non-optimal conclusions. (I see the time and effort savings of not having to undertake site-specific analyses, but I can’t evaluate the possible trade-offs.)

(I perceive evidence that this point is already well recognized, but anyway): I think any good method will include healthy respect for water quantity in addition to seasonal and annual patterns of variation in streamflow. I have detected in some examples a lack of attention to the scale of the y axis of proposed hydrographs that could threaten the sustainability of fish assemblages. In many California settings assemblages would be better off with more dry-season flow than those they evolved under…

My perception is meaningful answers to questions 1 & 2 depend entirely on the specifics of how the assemblages and geographic clusters will be used. I’m not clear on how the delineations of clusters would be an improvement on the apparent “Tier 2” alternative of establishing site-specific ecological flow criteria, as in the successful Putah Creek example. (I guess there must be some site-specificity built in? The doc and the web map show how assemblages vary dramatically within clusters…)

To flesh this out, here are some parts of the document that describe the approach that I didn’t understand:

*“In order to relate streamflow conditions directly to aquatic species community composition and life history requirements for taxa of concern, we developed an approach to determine flow-sensitive fish assemblages across California that are geographically distinct and, thus, are assumed to have evolved under historical hydrologic conditions.”*

Is this suggesting meaningful evolutionary units at the cluster scale? The clusters seem too fine for that. This also seems to contain the assumption that evolution produces optimal or at least pretty good outcomes – and on fine scales. Here’s a counter example: historically, coho salmon throughout much of their range in California did great in rain-dominated systems. But the most successful coho salmon in California over the last few millennia have probably been those that found their way to springs on the Shasta River…

*“The purpose of this analysis is to provide a unit (i.e., fish assemblages) upon which to base flow management recommendations in order to reach a biological outcome broader than single-species approaches to environmental flows.”*

How will this important and excellent objective play out in practice? I imagine that when Peter Moyle et al. developed flow regimes to support the native fish assemblage in Putah Creek, the approach included consideration of various single-species process connections in addition to application of the general idea of matching historic flow patterns. My perception is the best approaches to flow regulation will include entire assemblages, but also focus on key processes affecting key taxa. I think that argues for site-specificity at the “Tier 2” level.

One detail to add to the site-specificity issue is that a reasonable process of setting flows might distinguish between “flow-sensitive” species and “flow-sensitive species vulnerable to extinction” or “flow-sensitive species for which the watershed at hand is absolutely critical.”

*“Once assemblages are finalized, they will be tied to specific hydrologic conditions and flow metrics to inform environmental flow recommendations.”*

How? If the “ties” are made through purely statistical means, I would anticipate substantial risk of having certain species influence outcomes for idiosyncratic statistical reasons and that the specific spatial resolution of the clusters could be highly influential.

I’m not really getting the apparent distinction between “flow-sensitive species” and “riverine species resilient to hydrologic alteration” in Grantham et al. 2014. To the extent the approach at hand relies on this distinction, it seems to be worth addressing. Example: a bunch of flow-sensitive sculpins versus coastrange sculpin. The latter relies on fast-water to provide habitat for juveniles and adults and seasonal flows to move larvae downstream. What characteristics make the other sculpins more flow-sensitive?

No problem at all here if Peter and/or Ted explained this in a way that makes having this method continue to entirely rely on their list make sense.