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To: State Water Resources Control Board
Attn: Mr. Parker Thaler

From: Quartz Valley Indian Reservation
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Date: January 29, 2016

Re: Comments on *Notice of Preparation and Scoping Meetings for an Environmental Impact Report for the Klamath Hydroelectric Project Relicensing*

INTRODUCTION/SUMMARY

The "*Notice of Preparation and Scoping Meetings for an Environmental Impact Report for the Klamath Hydroelectric Project Relicensing*" (NOP) was issued by California's State Water Resources Control Board (SWRCB) in December 2015. To assist the Tribe in preparation of their comments on the NOP, our consultants have reviewed the documents and prepared the comments provided. These comments focus almost exclusively on water quality issues.

The effects of PacifiCorp's Klamath Hydroelectric Project (KHP) on water quality have been assessed in several previous efforts including by the Federal Energy Regulatory Commission (FERC 2007) and the U.S. Department of the Interior and California Department of Fish and Game (US DOI and CDFG 2012). Overall, the water quality information presented in those two documents is of high quality and provides a solid foundation to inform SWRCB's development of an Environmental Impact Report (EIR) for a Clean Water Act section 401 water quality certification for the relicensing or decommissioning of the KHP. The US DOI and CDFG (2012) document was prepared more recently and is more comprehensive so we recommend that SWRCB reply on it more heavily than the FERC (2007) document in cases where different conclusions are reached (e.g., the effect of the reservoirs on nutrient dynamics).

The Klamath Hydroelectric Project (KHP) has an overall negative effect on Klamath River water quality, and is causing violations of California's water quality standards including the Klamath River TMDL (NCRWQCB 2010). SWRCB's obligation under section 401 of the Clean Water Act (CWA) is to determine how the operation of the KHP can be modified in order to comply with California's water quality standards. The menu of experiments and water quality improvement measures described in PacifiCorp's (2014) Reservoir Management Plan fall far short of what would be needed to comply with California's water quality standards. Despite a decade of experimentation and study, PacifiCorp has yet to offer a specific plan for how a combination of techniques could be jointly implemented to actually meet water quality standards. The lack of such a plan is extremely revealing. The simple truth is that there are no feasible means besides dam removal for mitigating the KHP's two most consequential water quality impacts: alteration of water temperature and promotion of toxic cyanobacterial blooms.

We organize our comments below into three sections:

- Section 1: Overview of Klamath Hydroelectric Project (KHP) Effects on Water Quality
- Section 2: Evaluation of PacifiCorp's Interim Measure 11 Studies and Reservoir Management Plan
- Section 3: Recent and Upcoming Documents Relevant to Klamath River Water Quality That Were not Included in FERC EIS or Secretarial Determination EIS/EIR

We have also provided a separate list of references cited for each section rather than a single comprehensive list.

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SECTION 1: OVERVIEW OF KLAMATH HYDROELECTRIC PROJECT (KHP) EFFECTS ON WATER QUALITY

Summary of KHP Effects on Water Quality

As summarized in the following section, the Klamath Hydroelectric Project (KHP) has an overall negative effect on Klamath River water quality. These effects include increased water temperatures in late summer/fall, cyanotoxins, substrate armoring, and release of water from Iron Gate reservoir with high ammonia, low dissolved oxygen, and high pH; however, the KHP also has some potentially positive effects including reduced nitrogen concentrations and cooling water temperatures in spring. These positive and negative effects generally diminish with increasing distance downstream of Iron Gate (although due to bioaccumulation of cyanotoxins transported from the reservoirs, effects on public health and biota continue to the river mouth and potentially to the costal margin). The river immediately below Iron Gate is very important due to high spawning use by chinook salmon, so effects in that reach are of particular concern.

All negative water quality effects of the reservoirs can be eliminated by dam removal. Nitrogen concentrations would likely increase long-term following dam removal (due to loss of nutrient retention within the reservoirs and more rapid downstream transit of water), but this is not likely to deleteriously affect D.O. and pH because downstream periphyton (algae attached the riverbed) communities are comprised of nitrogen-fixing species that can flourish even when nitrogen concentration is low. Thus, the effects of increased nitrogen are not likely to be outweighed by other effects of dam removal that would favor lower periphyton biomass, such as a more dynamic flow regime and restored sediment transport.

In this section we present a brief summary, including references, of the impacts of the Klamath Hydroelectric Project (KHP) on Klamath River water quality. For additional details, we refer to the following documents that Tribes have previously placed into the FERC record (KTOC 2006a, 2006b; QVIR 2006; QVIC 2006; Yurok Tribe 2006a, 2006b; HVT 2006a, 2006b; Resighini Rancheria 2006a, 2006b), as well as the references cited herein.

KHP Effects on Specific Aspects of Water Quality

Cyanobacteria and cyanobacterial toxins

► Microcystin toxins produced by the toxic cyanobacteria (blue-green algae) *Microcystis aeruginosa* represent a substantial threat to human and animal health (OEHHA 2005; Kann 2006; Kann and Corum 2006, 2007; OEHHA 2012). The Klamath River is listed as impaired by microcystin toxins from Stateline to its confluence with the Trinity River[1]. Microcystin concentrations generally decline with distance downstream of Iron Gate Dam (US DOI and CDFG 2012) but frequently exceed public health guidelines between Iron Gate and Orleans, and occasionally exceed public health and water quality criteria as far downstream as the Klamath Estuary (HVTEPA 2013, YTEP Annual Blue-Green Monitoring Reports[2]). More recent genetic fingerprinting research showed that Iron Gate Reservoir is the source of downriver *Microcystis* assemblages and that Iron Gate Reservoir was determined to be the principal source of *Microcystis* found throughout the lower 300 km of river separating the reservoir from the Pacific Ocean (Otten et al. 2015).

► In the presence of abundant nutrients, the transformation from river to reservoir environment leads to massive blooms (Kann 2006; Kann and Corum 2006, 2007). Although nutrients are necessary for bloom proliferation, such concentrations alone are not sufficient to cause the

[1] Final 2012 California Integrated Report (Clean Water Act Section 303(d) List / 305(b) Report) http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2012.shtml
[2] Yurok Tribe Environmental Program: http://www.yuroktribe.org/departments/ytep/water_reports.htm

magnitude of blooms observed in Copco and Iron Gate reservoirs. As a consequence, despite similar nutrient loads, *Microcystis* is uncommon in the free-flowing river reach above Copco.

▶ There are higher levels of microcystin toxin and *Microcystis* cell density below the Copco-Iron Gate reservoir complex than above the reservoirs (Kann and Asarian 2007; Kann and Corum 2006, 2007; CH2MHill 2008; Asarian and Kann 2011).

▶ PacifiCorp's KHP provides ideal habitat for *Microcystis* by transforming turbulent free-flowing river reaches into stagnant thermally-stratified impoundments that favor cyanobacterial proliferation. For example, US DOI and CDFG (2012) concluded: "Removal of the dams would eliminate the lacustrine environment that currently supports ideal growth conditions for toxin-producing nuisance algal species such as M. aeruginosa." and "Under a dam removal with KBRA implementation scenario, the production of algal toxins in Copco 1 and Iron Gate reservoirs would be eliminated. The algae producing these toxins do not grow in a free flowing river." In addition, as concluded by Otten et al. (2015), there was no evidence of endemic *Microcystis* populations in the flowing regions of the Klamath River, both upstream and downstream of Copco and Iron Gate Reservoirs, indicating that the river itself does not represent good cyanobacterial habitat.

▶ Samples collected in 2007 indicate microcystin bioaccumulation in freshwater mussels from the Klamath River below Iron Gate, and in yellow perch from Iron Gate and Copco Reservoirs. Concentrations of microcystin in the organisms indicated that consumption of such organisms would exceed established public health advisory values (Kann 2008, OEHHA 2008). In 2009, freshwater mussels collected from the Klamath River between Iron Gate Dam and the Yurok Reservation also showed microcystin levels above public health advisory values (Kann et al. 2010). Such bioaccumulation in the lower river occurred despite very low ambient microcystin concentrations indicating that even when ambient concentrations do not exceed public health guidelines that shellfish may be unsafe for consumption. Furthermore, as demonstrated in Monterey Bay, microcystin exported from upstream lakes can be bioaccumulated in marine animals (e.g., sea otters) that consume shellfish containing algal toxins (Miller et al. 2010). Although yet to be monitored for in the Klamath system there is great potential for algal toxin bioaccumulation in sea mammals, sea birds, and other biota in the estuary and near-coastal environment.

▶ Although only limited data are available regarding the concentrations of microcystin toxins in tissues of Klamath Basin salmonids, data from 2007 indicate microcystin bioaccumulation in juvenile salmonids reared in Iron Gate hatchery (Kann 2008). In addition, trace concentrations of microcystin were found in Klamath River steelhead livers in 2005 (Fetcho 2006). Analysis of salmonid tissue samples collected by the Karuk Tribe also showed that Klamath River salmonids (chinook salmon and steelhead) were exposed to microcystin and that bioaccumulation in liver tissue occurred with concentrations in several fish livers exceeding public health guideline values (Kann et al. 2013). Although histopathological results were inconclusive, the measured toxins in livers point to the potential for recurring microcystin exposure and subsequent bioaccumulation of microcystins in Klamath River Salmonids

▶ Laboratory and field studies from elsewhere have demonstrated toxic effects of microcystin on salmonids (Andersen et al. 1993, Bury et al. 1997, Landsberg 2002) and other fish (Smith et al. 2008). Based on these studies, and the documented prevalence of microcystin the Klamath River, the potential clearly exists for sublethal (e.g., stress and disease) effects on salmonids from exposure to algal toxins.

▶ Other than dam removal, PacifiCorp has yet to demonstrate mitigations likely to effectively remedy the *Microcystis* problem. For example, Solar Bee circulators deployed in Copco

Reservoir by PacifiCorp in 2008 did not appear to be effective at reducing microcystin concentrations (CH2MHill 2008), and a plastic curtain installed at the Iron Gate log boom did not prevent a pulse of *Microcystis* cells from moving downstream in September of 2008.

Temperature

Primarily due to the thermal mass of Iron Gate and Copco reservoirs, the KHP significantly alters water temperatures in the Klamath River (FERC 2007, PacifiCorp 2004, PacifiCorp 2005c) in ways that are detrimental to the various runs of anadromous fish in the Klamath River.

► The KHP causes warm temperatures in the fall, negatively impacting fall Chinook salmon spawning success and egg survival, and resulting in a delay in spawning run-timing of several weeks.

► The KHP cools the river in early spring, which depresses the growth and survival of juvenile salmonid during this critical life history stage because it keeps water temperature below the optimum growth temperatures for juvenile salmonids. The resulting smaller-sized Chinook salmon juveniles migrate downstream more slowly than would larger individuals (PFMC 1994) and are less likely to survive to maturity and to spawn (Nicholas and Hankin 1988). This increased transit time exposes them to prolonged stress, increasing their likelihood of becoming infected with parasites.

► PacifiCorp has acknowledged that adjustment in operation (e.g. using selective withdrawals, curtains, or flow augmentation) cannot effectively mitigate for these temperature impacts (PacifiCorp 2005a, 2005b; Scott 2005).

► The Klamath River TMDL requires that water released from Iron Gate and Copco Reservoirs cause "Zero temperature increase above natural temperatures"(NCRWQCB 2010). Dam removal is the only method that is likely to reverse these KHP impacts to water temperatures.

Nutrients

► By replacing a formerly free-flowing river with a series of reservoirs, peaking reaches, and bypass reaches, the KHP has greatly altered the hydrologic, physical, chemical, and biological processes of the Klamath River.

► To provide a range of estimates for how total phosphorus (TP) and total nitrogen (TN) concentrations at Iron Gate Dam might change under a dam removal scenario for the months of June through October, Asarian et al. (2010) compared relative retention rates in river reaches with results from a study of the Copco-Iron Gate Reservoir complex by Asarian et al. (2009). The results indicated that dam removal will result in only a very small increase in TP concentration in the Klamath River between Iron Gate and Turwar. TN concentrations will increase 37-42% at Iron Gate, with the magnitude of the increase diminishing with increasing distance downstream. The effect on TN is substantially diminished by Orleans and quite small at Turwar. The implications of this increase is discussed in the "Dissolved oxygen and pH" sub-section below.

► As PacifiCorp itself (2005d) has acknowledged, peaking and bypass operations inhibit the river's capacity to assimilate nutrients within the KHP area. Bypass operations also inhibit the decomposition of organic matter, passing on a greater oxygen demand to downstream river reaches. Due to insufficient data, such effects were not included in predictions of nutrient concentration by Asarian et al. (2010) cited above.

Dissolved oxygen and pH

► Photosynthesis and respiration by periphyton (algae attached the riverbed) and aquatic plants in the Klamath River can degrade dissolved oxygen and pH conditions, resulting water quality that is chronically stressful to fish (HVTEPA 2008, NCRWCB 2010, Asarian and Kann 2013).
► The KHP has a direct effect on D.O. and pH levels in the Klamath River immediately below Iron Gate Dam (FERC 2007). During the summer season the reservoir often releases water with high pH and low D.O. (Asarian and Kann 2013), which could harm salmonids in the vicinity of the dam. Phytoplankton blooms from KHP reservoirs tend to decrease daily minimum dissolved oxygen concentrations in the Klamath River, presumably by reducing light availability and rates of production from periphyton (Genzoli 2013, Genzoli and Hall, in review, Genzoli et al. 2015).
► The KHP dams interrupt the downstream transport of gravel, resulting in more coarse stream substrates (Biggs 2000). The Klamath Hydroelectric Project has had this effect on the Klamath River below Iron Gate Dam (FERC 2007). Larger substrate materials like cobble and boulder require higher flows to scour them than smaller substrates like gravel and sand. These coarse substrates are more stable, increasing the amount of periphyton and aquatic macrophytes than can grow (Biggs 2000, Anderson and Carpenter 1998), which in turn increases diel fluctuations in pH and D.O.
► Although nitrogen concentrations are predicted to increase in the mainstem Klamath River downstream of the dams following dam removal (Asarian et al. 2010), this is not likely to deleteriously affect D.O. and pH because periphyton communities are comprised of nitrogen-fixing species that can convert abundant atmospheric nitrogen into biologically available forms and flourish even when nitrogen concentrations are low (Asarian et al. 2014, Asarian et al. 2015, Gillett et al. 2016). Thus, increased nitrogen is not likely to increase periphyton biomass and would actually likely be outweighed by other effects of dam removal that would likely reduce periphyton biomass, such as a more dynamic flow regime and restored sediment transport.

Ammonia toxicity
► Data clearly show that ammonia concentrations are often substantially higher below Iron Gate Dam than above Copco Reservoir (Asarian et al. 2009, Kann and Asarian 2007, FERC 2007, Asarian and Kann 2011). These higher concentrations represent a localized toxicity risk to fish in the river below Iron Gate.

Fish parasites
The KHP promotes infection of salmonids by the myxosporean parasites *Ceratonova shasta* and *Parvicapsula minibicornis* in the Klamath River through:
► Providing habitat for the polychaete *M. speciosa* by:
- Increasing substrate stability below Iron Gate Dam (see "Dissolved oxygen and pH" sub-section above)(FERC 2007)
- Increasing the stability of the hydrograph below Iron Gate Dam by regulating flow of tributaries from Keno to Iron Gate Dam.

► Increasing salmon spawning density below Iron Gate Dam by blocking fish passage, delivering massive loads of myxospores in an area with high polychaete populations, which results in high infection prevalence of polychaetes in an area of salmon crowding (FERC 2007, Stocking 2006, Stocking and Bartholomew 2007).
► Deteriorating pH and D.O. conditions and increasing ammonia, which are conditions created by the KHP cause stress and immunosuppression in salmonids, increasing the likelihood that they will become infected and diseased (FERC 2007).

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SECTION 2: EVALUATION OF PACIFICORP'S INTERIM MEASURE 11 STUDIES AND RESERVOIR MANAGEMENT PLAN

Summary of PacifiCorp's Interim Measure 11 studies and Reservoir Management Plan

With the stated goal to improving water quality within Copco and Iron Gate Reservoirs and the Klamath River downstream, PacifiCorp has conducted a series of activities under the Klamath Hydroelectric Settlement Agreement (KHSA) Interim Measures 10 and 11 and developed a Reservoir Management Plan (RMP) and (PacifiCorp 2014). Although PacifiCorp correctly state that the source of nutrient enrichment for the reservoirs is the result of upstream nutrient and organic matter loads, they do not directly acknowledge that the dams create the lacustrine habit required for the large and toxic cyanobacteria blooms that currently dominate (see above discussion and references). The RMP then proposes to implement management techniques that are aimed at improving reservoir water quality conditions related to nutrients, algae, dissolved oxygen and pH[3].

However, despite the aim of the RMP and the statement that the RMP "will also help to improve water quality in the Klamath River below the Project reservoirs" and "The implemented techniques, particularly when combined with implementation of appropriate TMDLs to control and reduce nutrient loads upstream of the Project, are expected to provide appreciable and sustained water quality enhancements in and below Copco and Iron Gate reservoirs" (PacifiCorp 2015a), no data or evidence are provided for how the proposed techniques will reduce toxic cyanobacteria blooms to meet Clean Water Act and public health thresholds. Rather, for those techniques that relate to cyanobacteria reduction, the RMP references ongoing evaluation of the techniques, many of which have not moved past the modelling phase (e.g., surface mixing and circulation and reservoir drawdown), and for those that have, some have been discounted (e.g., destratification, solar powered circulators, phosphorus inactivation), and others have only undergone small scale testing. Those in the latter category (chiefly application of algaecide and implementation of an intake barrier to reduce algal entrapment downriver), have either been shown to be completely ineffective (algaecide) or existing studies have yet to show improvement in downstream conditions (intake barrier). Moreover, PacifiCorp has not provided information on how any of the proposed projects would be scaled to the size necessary to improve water quality on a reservoir-wide basis (even assuming water quality could be improved on a small scale basis such as in an isolated cove), let along what the cost of such full-scale implementation would be.

The water quality improvement measures described in the RMP fall far short of what would be needed to comply with California's water quality standards. The current RMP is really more a menu of options or a study plan than it is a management plan. The RMP described various techniques, including conceptual ideas for how the techniques could be applied in Iron Gate and Copco Reservoirs, but there are no details provided regarding at what scale the techniques would be applied, what capital and maintenance costs would be, and what expected water quality outcomes would be. Despite a decade of experimentation and study, PacifiCorp has yet to offer a specific plan for how a combination of the techniques could be jointly implemented to meet

[3] (1) constructed treatment wetlands; (2) reservoir and tailrace aeration and oxygenation systems; (3) epilimnion (surface water) mixing and circulation; (4) selective withdrawal and intake control; (5) reservoir drawdown and fluctuation; and (6) algaecide treatment.

water quality standards. The lack of such a plan is extremely revealing. The simple truth is that there are no feasible means besides dam removal for mitigating the KHP's two most consequential impacts to water quality: alteration of water temperature and promotion of toxic cyanobacterial blooms.

The various Klamath River Tribes (as well as other federal and state agencies) have been evaluating and commenting on the management techniques proposed in the RMP as part of PacifiCorp's Interim Measure 11 studies (which consist of testing, design, or modelling) to address water quality conditions (Table 1)[4]. Those comments support our statement above that none of the proposed RMP projects have been demonstrated to improve cyanobacterial related water quality violations or public health. In the following sub-sections, we provide an overview of the major components of PacifiCorp's Interim Measure 11 studies and the Reservoir Management Plan.

[4] The list in Table 1 may not be exhaustive and therefore we request that SWRCB contact the Klamath Basin Tribes and other members of the Interim Measures Implementation Committee to obtain other relevant documents.

Table 1. List of 1) PacifiCorp IM11 study plans, 2) Tribal comments on PacifiCorp's IM11 study plans and draft reports, and 3) PacifiCorp responses to Tribal comments. Check boxes on left side of table indicate which topics/approaches are addressed in each document. Documents are sorted by date. Some of the dates are approximate (i.e., within a month). All documents listed were organized into folders according to Document Type and uploaded to an online archive accessible at: https://www.dropbox.com/s/exc6fkhmaiz7sw3/IM11_docs.zip

In-reservoir		Nutrient Reduction				Other				
Algaecides	Oxygenation/ Mixing	Iron Gate Outlet	Wetlands	Algae/OM remove	Chem. sequestration	KTAP	Approx. Date	Document Type	Document Filename(s)	Document Title and/or Citation
x	x	x	x	x		x	8/10/10	PacifiCorp IM11 study plan	PC Interim Measure 11 Plan - Draft.doc	Klamath Hydroelectric Settlement Agreement Implementation: Proposed Activities Related to Interim Water Quality Improvements (Interim Measure 11), preliminary draft
x	x	x	x	x			8/23/10	Tribal comment on PacifiCorp IM11 study plan	kier_imic_wq_study_plan_comments_2010 08 24.doc	Asarian, Eli. 2012. Comments regarding Klamath Hydroelectric Settlement Agreement Implementation: Proposed Activities Related to Interim Water Quality Improvements (Interim Measure 11). From: Eli Asarian, Kier Associates. Date: August 23, 2010.
x	x	x	x	x		x	10/18/10	PacifiCorp IM11 study plan	IM 11 Studies Cost Summary _Oct 18 2010_.pdf, IM 11 Study Plan Copco Algaecide _Oct 18 2010_.pdf, IM 11 Study Plan Iron Gate Intake _Oct 18 2010_.pdf, IM 11 Study Plan JC Boyle DO _Oct 18 2010_.pdf, IM 11 Study Plan Keno OM Removal _Oct 18 2010_.pdf, IM 11 Study Plan Treatment Wetlands _Oct 18 2010_.pdf, IM 11 Study Plan WQ Accounting _Oct 18 2010_.pdf	[final IM11 study plans for 2010, separate document for each study plan]
x			x	x			11/16/10	Tribal comment on PacifiCorp IM11 study plan	Yurok Comments on IM 11 Final Plans 111610.docx	Fetcho, Ken. Yurok Tribe Comments prepared with assistance from Eli Asarian on 3 Final Study Plans. Yurok Tribe, November 16, 2010.

In-reservoir		Nutrient Reduction				Other				
Algaecides	Oxygenation/ Mixing	Iron Gate Outlet	Wetlands	Algae/OM remove	Chem. sequestration	KTAP	Approx. Date	Document Type	Document Filename(s)	Document Title and/or Citation
x			x	x		x	5/13/11	PacifiCorp's response to comments on IM11 study plan	IMIC_IM11 Comment_Table_5-13-2011.pdf	PacifiCorp. 2011. PacifiCorp Responses to IMIC Comments on Interim Measure 11 Study Plans.
							4/27/12	Tribal comment on PacifiCorp IM11 report	2012.04.27 Yurok_PC Comments Draft Wetland Rpt.pdf	Fetcho, Ken. 2012. Comments letter to Tim Hemstreet, PacifiCorp. Subject: Yurok Tribe Comments on the draft document "Approaches to Water Quality Treatment by Wetlands in the Upper Klamath Basin". From: Ken Fetcho, Yurok Tribe. Date: April 27, 2012.
x	x	x	x	x		x	6/25/12	PacifiCorp IM11 study plan	IM11-WQStudyProgressRpts_June 2012.pdf	PacifiCorp. 2012. Klamath Hydroelectric Settlement Agreement Interim Water Quality Improvements (Interim Measure 11) Water Quality Study Progress Reports June 25, 2012
x		x		x			10/31/12	Tribal comment on PacifiCorp IM11 study plan	kier_imic_wq_study_plans_comments_20121031.doc	Asarian, Eli. 2012. Memo to Klamath Basin Tribal Water Quality Work Group. RE: Comments regarding Klamath Hydroelectric Settlement Agreement (KHSA) Interim Measure 11 water quality studies for 2012-2013. From: Eli Asarian, Kier Associates. Date: October 31, 2012. [note: header has incorrect date 9/31/2012]
x		x		x			12/31/12	PacifiCorp's response to comments on IM11 study plan	IM 11 Study Comment Response (Dec 31 2012) F.pdf	PacifiCorp. 2012. PacifiCorp Responses to Comments from IMIC Members on Interim Measure 11 Studies (Received October 29 to November 9, 2012).
x		x	x	x			2/28/13	Tribal comment on PacifiCorp IM11 study plan	Yurok comments 2013 IM 11 022813.pdf	Fetcho, Ken. 2013. Comments letter to Tim Hemstreet, PacifiCorp. Subject: Yurok Tribe Comments and Recommendations for 2013 IM 11 Water Quality Studies. From: Ken Fetcho, Yurok Tribe. Date: February 28, 2013.
x		x	x	x			3/4/13	Tribal comment on PacifiCorp IM11 study plan and reports	Karuk IM 11 Comments_3.04.13.pdf	Bowman, Crystal. 2013. Memo to Tim Hemstreet, PacifiCorp. RE: Review and recommendations for Klamath Hydroelectric Settlement Agreement (KHSA) Interim Measure 11 water quality studies. From: Crystal Bowman, Karuk Tribe. Date: March 4, 2013.
x		x	x	x	x	x	5/9/13	Tribal comment on PacifiCorp IM11 study plan and reports	IMIC IM 11 2013 Project Comments Karuk Tribe 05.09.13.pdf	Bowman, Crystal. 2013. Memo to Tim Hemstreet, PacifiCorp. RE: Review and recommendations for Klamath Hydroelectric Settlement Agreement (KHSA) Interim Measure 11 water quality studies 2013-2014. From: Crystal Bowman, Karuk Tribe. Date: May 9, 2013.

In-reservoir		Nutrient Reduction				Other				
Algaecides	Oxygenation/ Mixing	Iron Gate Outlet	Wetlands	Algae/OM remove	Chem. sequestration	KTAP	Approx. Date	Document Type	Document Filename(s)	Document Title and/or Citation
x		x	x	x	x	x	5/10/13	Tribal comment on PacifiCorp IM11 study plan	Yurok comments 2013-2014 IM 11 Study Plan 051013.pdf (and identical MS Word version: Yurok comments 2013-2014 IM 11 Study Plan 051013.pdf)	Fetcho, Ken. 2013. Comments letter to Tim Hemstreet, PacifiCorp. Subject: Yurok Tribe comments and recommendations for Klamath Hydroelectric Settlement Agreement (KHSA) Interim Measure 11 water quality studies 2013-2014 . From: Ken Fetcho, Yurok Tribe. Date: May 10, 2013.
x		x		x			5/16/13	Tribal comment on PacifiCorp IM11 report	Karuk Comments_ IM 11 Project Reports 2012.pdf	Bowman, Crystal. 2013. Memo to Tim Hemstreet, PacifiCorp. RE: Comments of PacifiCorp 2012 Draft Reports. From: Crystal Bowman, Karuk Tribe. Date: May 16, 2013.
x		x		x			5/17/13	Tribal comment on PacifiCorp IM11 report	Yurok comments 2012 IM 11 Draft Reports 051713.pdf	Fetcho, Ken. 2013. Memo to Tim Hemstreet, PacifiCorp. Subject: Yurok Tribe comments and recommendations for Klamath Hydroelectric Settlement Agreement (KHSA) Interim Measure 11 water quality studies 2013-2014. From: Ken Fetcho, Yurok Tribe. Date: May 17, 2013.
x							9/6/13	PacifiCorp's response to comments on IM11 study plan	Activity 5 Karuk Comment Response (Sep 6 2013).pdf	PacifiCorp. 2013. Responses to Comments of the Karuk Tribe on the Implementation and Monitoring Plan for the 2013 Environmentally-Safe Algaecide Application in Long Gulch Cove, Iron Gate Reservoir September 6, 2013
					x		1/30/14	Tribal comment on PacifiCorp IM11 study plan	IMIC Karuk Comments_Activity 7 Bench Testing IM 11 Draft Study Plan 02.03.14.pdf	Bowman, Crystal. 2014. Memo to PacifiCorp and Interim Measures and Interim Conditions Committee. RE: Review and comment on Interim Measure 11 Study Activities for 2013-2014, Activity : Pilot Study of Nutrient Reduction Methods in Klamath Basin Waterbodies, Initial Testing Approach and Prodeedures (Review Draft). From: Crystal Bowman, Karuk Tribe. Date: January 30, 2014.
					x		3/12/14	PacifiCorp's response to comments on IM11 study plan	IM Activity 7 Comments Responses f _Mar 12 2014_.pdf	PacifiCorp. 2014. Table B-1. Responses to Comments on the Activity 7 Draft Study Plan. March 12, 2014.
		x					3/24/14	Tribal comment on PacifiCorp IM11 report	KHSA IM 11 Iron Gate Intake Comments_Karuk Tribe 3.24.14.pdf	Bowman, Crystal. 2014. Memo to Tim Hemstreet and Linda Prendergast, PacifiCorp. RE: Review and comment on Assessment of an Intake Barrier for Water Quality Control at Iron Gate Reservoir - 2013 Study Results (Draft). From: Crystal Bowman, Karuk Tribe. Date: March 24, 2014.

In-reservoir		Nutrient Reduction				Other				
Algaecides	Oxygenation/ Mixing	Iron Gate Outlet	Wetlands	Algae/OM remove	Chem. sequestration	KTAP	Approx. Date	Document Type	Document Filename(s)	Document Title and/or Citation
x							5/6/14	Tribal comment on PacifiCorp IM11 report	Karuk_algaecide report comments_2013.docx	Corum, Susan. 2014. Karuk Tribe comments on: "2013 Localized Treatment of Long Gulch Cove in Iron Gate Reservoir Using Environmentally Safe Algaecide, Draft Technical Report, April 2014. Prepared for PacifiCorp by Watercourse Engineering Inc."
			x				5/20/14	Tribal comment on PacifiCorp IM11 report	Kier_IM11_Wetlands_20140520_draft.doc	Asarian, Eli. 2014. Memo: to Klamath Basin Tribal Water Quality Work Group. RE: Review and comments on (Draft) Demonstration Wetland Facility Preliminary Research and Implementation Plan Klamath River, Oregon. From: Eli Asarian. Date: May 20, 2014
			x				10/20/14	Tribal comment on PacifiCorp IM11 report	Kier_IM11_Wetlands_20141021_draft.doc	Asarian, Eli. 2014. Memo to: Klamath Basin Tribal Water Quality Work Group. Review and comments on (Final Draft) Demonstration Wetland Facility Preliminary Research and Implementation Plan Klamath River, Oregon. From: Eli Asarian. Date: October, 2014 [note: header has incorrect date 5/13/2014]
				x			11/18/14	Tribal comment on PacifiCorp IM11 report	Karuk_IM11_OrgRemove_11.18.14.doc	Corum, Susan. 2014. Memo to: Pacificorp and Interim Measures Implementation Committee. Re: Review and comments on (Draft) Conceptual Design Evaluation for Full-Scale Particulate Organic Matter Removal from Klamath River Source Water Using Stormwater Treatment Technology, 2013. From: Susan Corum, Karuk Tribe. Date: Nov 18, 2014.
				x			11/21/14	Tribal comment on PacifiCorp IM11 study plan	KHSA_IM11_AlgalRemoval_20150112 1.docx	Corum, Susan. 2014. Conceptual Proposal for Removal of Algae Near Outlet of Upper Klamath Lake and Evaluation of Options for Re-Use. November 21, 2014.
	x	x	x	x		x	2/5/15	Tribal comment on PacifiCorp IM11 study plan	Karuk.studyplancomments.2015.020515.doc	Corum, Susan. 2015. Memo to: PacifiCorp and Interim Measures Implementation Committee. Re: Review and comment on Draft Study Plan Klamath Hydroelectric Project Interim Measure 11 Study Activities for 2015. From: Susan Corum, Karuk Tribe. Date: February 5, 2015.
				x			2/23/15	Tribal comment on PacifiCorp IM11 study plan	Karuk.2015.7.8.Comments.022315.pdf	Corum, Susan. 2015. Memo to: PacifiCorp and Interim Measures Implementation Committee. Re: Review and comment on Proposed IM11 study plans 7 (Algae Biomatter Utilization) and 8 (Algae Harvesting/Processing Methods and Removal Rates). From: Susan Corum, Karuk Tribe. Date: February 23, 2015.

In-reservoir		Nutrient Reduction				Other				
Algaecides	Oxygenation/ Mixing	Iron Gate Outlet	Wetlands	Algae/OM remove	Chem. sequestration	KTAP	Approx. Date	Document Type	Document Filename(s)	Document Title and/or Citation
x							2/25/15	Tribal comment on PacifiCorp IM11 report	Karuk_2014_Algaecide Report_comments.pdf	Corum, Susan. 2015. Memo to: Pacificorp and Interim Measures Implementation Committee. Re: Review and comment on Draft Technical Report: 2014 Localized Treatment of Long Gulch Cove in Iron Gate Reservoir Using Hydrogen Peroxide Based Algaecide. From: Susan Corum, Karuk Tribe. Date: February 25, 2015.
						x	4/9/15	PacifiCorp's response to comments on IM11 study plan	2014.04.16 Algaecide 2014 Comment Response.pdf	PacifiCorp. 2015. PacifiCorp Responses to Comments on the Draft Technical Report "Draft Technical Report - 2014 Localized Treatment of Long Gulch Cove in Iron Gate Reservoir Using Hydrogen Peroxide Based Algaecide". April 9, 2015.
	x	x	x	x		x	5/29/15	PacifiCorp IM11 study plan	IM 11 2015 WQ Study Plan F (May 29 2015).pdf	PacifiCorp. 2015. Study Plan Klamath Hydroelectric Project Interim Measure 11 Study Activities for 2015, May 29, 2015.
		x					6/10/15	Tribal comment on PacifiCorp IM11 study plan	2015.06.10 Karuk Comments-IM11-Study Activity 5.pdf	Corum, Susan. 2015. Memo to: PacifiCorp and Interim Measures Implementation Committee. Re: Review and comment on Proposed IM11 Study Plan for 2015: Study Activity 5. From: Susan Corum, Karuk Tribe. Date: June 10, 2015.

Comments on components of PacifiCorp's Interim Measure 11 studies and Reservoir Management Plan

Reduce nutrient load delivered to KHP reservoirs
As part of implementing the KHSA and in cooperation with other interested parties, PacifiCorp has been evaluating methods for reducing the amount of nutrients delivered from Upper Klamath Basin down the Klamath River into the KHP reservoirs. Activities have included convening a water quality workshop to evaluate various technologies (Stillwater Sciences et al. 2012, 2013) as well as funding a series of technical investigations of the potential to reduce nutrient loads using treatment wetlands (Lyon et al. 2009; CH2M HILL 2012, 2014), chemical application (CH2M HILL 2015), removal of algal biomass near Link Dam using stormwater technology (hydrodynamic separators, Watercourse Engineering, Inc. 2013b, 2014b, 2014c,) or other methods (PacifiCorp 2015).

Reducing nutrient loads is important endeavor and specific reductions are proscribed in Total Maximum Daily Loads (TMDLs) for Upper Klamath Lake (ODEQ 2002), the Lost River (ODEQ 2010), and the Klamath River (NCRWCB 2010, ODEQ 2010). PacifiCorp's assessments have provided useful information which could assist in informing future development of projects to reduce the nutrient loads coming from the Upper Klamath Basin. However, most of the assessments lack cost estimates for full-scale deployment, and the one study that did provide a cost estimate (organic matter removal near Link Dam, Watercourse Engineering Inc. 2014b) indicated the cost per units of phosphorus removed was quite high relative to other approaches previously considered in other assessments (Corum 2014b).

We are a long way from having the comprehensive strategy and sufficient resources that would be required to substantially reduce nutrient loads. Numerous scientific, economic, political, and cultural obstacles remain, but with intensive effort and substantial investment over several decades, it may be possible to obtain the major reductions in nutrient load called for in the TMDLs. But even if such reductions were eventually achieved, they would at best only reduce the magnitude of the harmful algal blooms within KHP reservoirs, not eliminate them. Given the mainstem location relatively low in the watershed, the reservoirs would continue to receive nutrients from the upper basin including its agricultural lands, and will continue to foster cyanobacterial blooms by creating lacustrine habitat required for the massive planktonic blooms of toxigenic cyanobacteria currently observed. Meeting water quality standards within Iron Gate and Copco Reservoirs will be exceedingly difficult as long as the reservoirs remain in place.

Algaecide control of cyanobacteria
PacifiCorp has been evaluating various algaecides as a potential tool to locally improve water quality conditions in high public use areas of its reservoirs since 2008 (Deas et al. 2009, 2012; Watercourse 2013a, 2014a, 2015). While PacifiCorp acknowledges that algaecide treatment is likely not economic or feasible for fully addressing algal concerns in Project Reservoirs (which alone implies that the technique will not allow the hydro project to be water quality compliant) they go on to state that preliminary study results indicate that algaecide can be successful in reducing algal concentration while also reducing microcystin concentrations (see PacifiCorp's 2014 Application for Water Quality Certification; KHSA Implementation Report p. 23). This statement is strongly overstated and inconsistent with results of the pilot algaecide studies on which the tribes have submitted extensive comments (PacifiCorp 2012, Bowman 2013, Fetcho

2013a, Corum 2014b, Corum 2015a). For example, in comments provided on PacifiCorp's Draft Technical Report: 2014 Localized Treatment of Long Gulch Cove in Iron Gate, we demonstrated that when consideration was given to the control dynamics and when actual concentrations were compared through the course if the experiment, it was apparent that the algaecide treatment was ineffective at controlling the toxic blooms in Copco Cove in 2012 (Corum 2015a). Specifically, the surface level of microcystin was higher post-event compared to pretreatment, and microcystin levels remained well above public health guideline values. Similarly for 2013, two out of three Post-Event samples in the integrated September sample from the treated area increased and showed much higher microcystin than all samples from the non-treated area showing that the treatment was not effective at reducing microcystin toxin (Corum 2014b). Finally regarding the 2014 study results, we also noted that algaecide treatment had little to no effect on microcystin or even increased it some instances, and in some cases algal biomass (chlorophyll) increased after some algaecide treatments (Corum 2015). It is clear from the IM 11 algaecide studies that algaecide application was not effective at controlling cyanobacterial blooms and toxins (in fact toxins often increased) in a small cove area, let alone on any scale that would allow the project to meet water quality criteria and public health objectives either in the reservoirs or downstream in areas of concern to the Tribes.

Selective withdrawal from Iron Gate Reservoir

PacifiCorp has pilot tested several configurations of selective withdrawal systems designed to reduce the amount of water withdrawn from the surface of Iron Gate Reservoir where algae are concentrated, with the goal of reducing the amount of *Microcystis* and associated toxins entrained into the Klamath River downstream. The initial design was a cover on the intake tower which did not work because after the cover was installed, the hydraulics adjusted to the presence of the intake (Miao and Deas 2014). In 2014 and again in 2015, a geotextile curtain was deployed upstream of the intake (PacifiCorp 2015).The Tribes have submitted extensive comments (Bowman 2013, 2014; Fetcho 2013a, 2013b, 2013c; Corum 2015b) on this IM 11 measure, and data to date do not show that the barriers tested were able to prevent cyanobacterial entrainment and prevent downstream public health exceedances of cyanobacteria and toxins. While results of the latest 2015 study are not yet available, previous testing showed the various barriers to be ineffective or not assessable due to poor study design. For example, comparisons of conditions in the reservoir vs. in the river downstream were not made on the same parcel of water in either 2012 or in 2013, and results were also confounded by diel patterns in the algae, patterns which PacifiCorp did not incorporate in their comparisons (Bowman 2014). Although they may be informative, study results for the 2015 intake barrier experiment will not provide the means to assess barrier efficacy due to very low algal and toxin levels above the barrier. Such a test would need to be performed in a year when algal concentrations are high (as often occurs) in order to evaluate whether the intake barrier might reduce downstream entrainment of cyanobacteria and toxins. Moreover, even low levels of toxins from Iron Gate Reservoir are associated with bioaccumulation in Klamath River mussels downstream (Kann et al. 2010), so marginal reductions in the amount of Microcystis released from Iron Gate Reservoirs will not be sufficient to meet all beneficial uses downstream.

Mixing

PacifiCorp is current conducting modelling to determine whether mixing water within reservoir coves could reduce cyanobacterial blooms (PacifiCorp 2015). This technology is yet another example in which the goal is only to improve water quality in localized areas (e.g., reservoirs coves), not to meet Clean Water Act and public health thresholds. Mixing could also potentially be used to destratify reservoirs rather than just coves (PacifiCorp 2014), but PacifiCorp has not proposed to attempt this in Iron Gate and Copco Reservoirs. As noted in the RMP "PacifiCorp does not propose to conduct further evaluation of potential destratification of Copco and Iron Gate reservoirs under this RMP" (PacifiCorp 2014).

Oxygenation

It is conceptually possible to use mechanical oxygenation to increase oxygen levels enough to meet dissolved oxygen criteria (MEI 2007, PacifiCorp 2014); however, it would be quite expensive and would not solved the reservoirs' other water issues (e.g., promotion of cyanobacteria blooms and alteration of water temperature).

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SECTION 3: RECENT AND UPCOMING DOCUMENTS RELEVANT TO KLAMATH RIVER WATER QUALITY THAT WERE NOT INCLUDED IN FERC EIS OR SECRETARIAL DETERMINATION EIS/EIR

In this section, we provide a list of recent and upcoming documents relevant to Klamath River water quality that were not included in the Secretarial Determination EIS/EIR (US DOI and CDFG 2012), plus a few of the most relevant documents that were not included in the FERC (2007) EIS but were included in the Secretarial Determination EIS/EIR[5]. These and other relevant documents can be found on the websites for Karuk Tribe (http://www.karuk.us/index.php/departments/natural-resources/somes-bar-water-quality), Yurok Tribe (http://www.yuroktribe.org/departments/ytep/index.htm), and the Klamath Tribal Water Quality Consortium's website (http://klamathwaterquality.com/documents.html)

In addition, we would like to take this opportunity to inform SWRCB of some studies/analyses that are currently in progress and therefore are not cited in the Specific Documents listed below, which include: 1) Klamath Tribal Water Quality Consortium's analysis of continuous phycocyanin probe data, 2) Karuk Tribe's analysis of 2011-2015 harmful algal bloom (HAB) monitoring, 3) Karuk and Yurok Tribes' analysis of diel patterns in cyanobacteria and microcystin.

We also request that SWRCB obtain all documents within the following categories, which we do not list individually in the Specific Documents list:

- All public health HAB memos through 2015 (both weekly and seasonal summaries) from PacifiCorp, the Karuk Tribe, and the Yurok Tribe.
- All Tribal annual reports on KHSA monitoring (e.g., continuous YSI data and nutrients).

Specific Documents

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[5] The Secretarial Determination EIS/EIR presents a quite comprehensive compilation of the water quality documents that were available at the time it was written, and including all the relevant documents cited there would overwhelm this list, which we intend to focus on the most recent information.

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If there are any questions or comments regarding these comments please contact me at the following: crystal.robinson@qvir-nsn.gov or 530-468-5907 ext 318.

Thank you for this opportunity to provide additional comments regarding the Klamath Hydroelectric Project and associated water quality.

Sincerely,

Crystal Robinson

Crystal Robinson
Environmental Director
Quartz Valley Indian Reservation

Update on Adenovirus Infection in Mule Deer (*Odocoileus hemionus*) 2014-2015 as of 7/30/15

Nicholas Shirkey, Ben Gonzales, Leslie Woods

Wildlife Investigations Lab, California Department of Fish and Wildlife and the California Animal Health and Food Safety Laboratory

History of Adenovirus in California

In 1993 and 1994 a significant mortality event impacted California's mule deer population across eighteen counties of Northern and Central California. Crude estimates at the time put the number of mortalities at over a 1000, primarily impacting fawns (Swift 1997, Woods et al. 1996). Necropsy findings in carcasses from the affected regions were similar to hemorrhagic disease caused by bluetongue virus (BTV) or epizootic hemorrhagic disease virus (EHDV). However, microscopic examination and transmission electron microscopy conducted by the California Animal Health and Food Safety Laboratory (CAHFS) discovered that a previously unrecognized adenovirus infection was the cause (Woods et al. 1996). The adenovirus was detected in carcasses from Siskiyou, Shasta, Tehama, Lake, Yuba, Nevada, Sacramento, Sonoma, Tuolumne, San Mateo, and Marin counties, and was suspected to be the cause of mortalities in Modoc, Trinity, Calaveras, Santa Clara, Monterey, San Luis Obispo, and El Dorado counties as well. It was also demonstrated in historical tissues dating as far back as 1987 in Sonoma County.

Description of the Disease

During the 1993/1994 and subsequent outbreaks, fawns were most impacted by the disease, though yearlings and adults were also affected. In inoculation studies, 80% of black-tailed fawns exposed to adenovirus developed the disease compared to 16% of yearlings (Woods et al., 1999; Swift, 1997). Because of the increased susceptibility of fawns, rehab centers that specialize in the care of abandoned fawns have been the site of adenovirus mortalities in Sonoma County in 1987, Nevada County in 1990, Nevada & Placer County in 1993, and Nevada County in 1994.

In contrast to BTV and EHD which spread via an insect vector, inoculation studies on adenovirus show that the disease spreads via direct contact (Woods et al., 1999, 2001). It also appears to be highly contagious with signs of infection appearing almost simultaneously in the inoculated animals and the animals they are in contact with. The incubation period of the disease ranges from 4-16 days post exposure with death occurring acutely afterwards (Woods et al., 1999). It is associated with high levels of mortality; 60% of fawns housed in a Nevada County rehab facility died during a 1994 outbreak (Swift, 1997). Typical symptoms found in infected animals included; excess salivation, diarrhea, regurgitation, seizures, and an affinity for sources of water (Woods et al., 1996, 1999; Swift 1997).

The deer adenovirus infection can take the form of both a systemic and localized infection. In both cases the primary impact of the virus is vasculitis or inflammation of the blood vessels. Inflammation of the endothelial cells lining the vessels can lead to necrosis or cell death and can result in leakage of fluid into the tissues, and loss of flow of oxygenated blood to regions of tissue.

In the systemic form of the infection the respiratory and digestive tracts are most affected by the disease. Vasculitis caused by the adenovirus is responsible for interstitial edema in the lungs, or a buildup of fluid, and in many cases can result in pneumonia (Woods et al., 1996). In the intestines the vasculitis can cause hemorrhage into the lumen or internal space (Woods et al., 1996). In both cases systemic infection by adenovirus can lead to acute death.

The localized form of the infection results in focal lesions throughout the upper alimentary tract and can cause infarcts with secondary bacterial infection and abscess formation (Woods et al., 2001b). Abscesses resulting from adenovirus have been noted in the lips, tongue, gingiva, hard palate, nasal cavity, pharynx, esophagus, and abomasum (Woods et al., 1999, 2001a). These lesions can also be present in animals showing signs of systemic infection. While the lesions themselves are unlikely to be life-threatening, they can lead to starvation or septicemia and therefore result in death.

Current Update

Adenovirus has been ruled as the cause of death in black-tailed deer (*Odocoileus hemionus columbianus*), and other subspecies of mule deer (*Odocoileus hemionus ssp*.) in several California counties starting in the summer of 2014 and continuing throughout the winter and spring of 2015. Adenovirus has been identified in eight of the seventeen deer that have been submitted to CAHFS in 2015 as of the 30th of July. This marks a substantial jump from the four deer, out of forty-eight, in which adenovirus was determined to be the cause of death in 2014, and the one deer from 2013. The twelve diseased deer from the 2014/2015 period were submitted from nine unique events spanning from June of 2014 to July of 2015 and came from Amador, El Dorado, Fresno, Marin, Mariposa, Shasta, Siskiyou, and Yolo counties.

As in past mortality events fawns have been most affected by the adenovirus with six of the twelve animals coming from this group. However, the fact that the majority of the deaths thus far in 2015 have occurred outside of the fawning season and that three of the four adults were reported to be in fair to good body condition with reasonable stores of fat is a reminder of the high morbidity and mortality associated with this disease.

For all twelve animals in 2014 and 2015 where adenovirus was positively identified in tissues, it was also determined to be the cause of death. All animals showed signs of the systemic infection with widespread vasculitis. Nine of the twelve animals had pulmonary edema characterized by an enhanced lobular pattern and ten had hemorrhagic enteropathy. Bloody diarrhea was noted in eight of the animals submitted for necropsy, but lesions associated with the localized form of the infection were not mentioned in any of the reports.

For the fifty-three deer submitted to CAHFS where adenovirus was not found, diagnoses varied widely (See Table 1 for full list). Animals were submitted from nineteen counties. Thirty of the animals had some pathology of the lung including; mild edema (9/53), abscesses, hemorrhage, and pneumonia (20/53). Other common findings were nutritional deficiencies (21/42 had a selenium deficiency and 18/41 had low tissue copper levels), encephalitis (7/53), myopathy (4/53), gastrointestinal disorder (12/53), and trauma (11/53). Though the agent of disease was not always identified, after adenovirus the bacterium *Trueperella pyogenes*, a common cause of secondary infection, was the greatest cause of pathology in the submitted deer (5/53). Other infectious agents included *Clostridium* sp., *Enterobacter* sp., EHD, Listeria encephalitis, Bibersteinia, and various endoparasites (*Parelaphostongylus odocoilei*, *Setaria*, Trichostrongyles, etc). Chronic wasting disease (CWD) samples were submitted from ten counties: El Dorado, Fresno, Kern, Madera, Sacramento, San Luis Obispo, Shasta, Siskiyou, Trinity, and Yolo. CWD was not found in any of the 17 deer tested, and was also negative in the obex and retropharyngeal lymph nodes of an additional 4 deer that were not included in this report from the 2014-2015 period. Adenovirus was the most common definitive cause of death, particularly in 2015 in which it accounted for 47% of the submissions.

Field Investigation

Current evidence indicates that we are in the middle of a significant period of adenovirus mortality, which may have begun in the summer of 2014. The factors resulting in increased adenovirus mortality in a given year remain as elusive today as they were in 1993, though the continued severity of the drought may very well play into the epidemiology of the disease as groups of deer congregate to acquire water and food resources. Deer may also congregate around artificial feeding sites and increase their exposure to infected deer. Biologists should keep an eye out for deer showing the following symptoms; excess salivation, diarrhea, regurgitation, and seizures (Woods et al., 1996, 1999; Swift 1997). Increased mortality of fawns should also be monitored, and fresh carcasses should be considered for necropsy.

Currently, we have a scattering of reports from around Northern and Central California, but past outbreaks of adenovirus indicate that we are now in the time of year where peak mortalities should be occurring. While estimating the impact of adenovirus mortality in herds across the state may be a difficult endeavor, accurate records should be maintained by local biologists to the extent possible to at least gauge the impact to local herds and to monitor the spread of the virus. Any indication of a mortality event taking place in your region should be reported to the big-game veterinarian for the Wildlife Investigations Laboratory, Ben Gonzales, (916) 358-1464, Ben.gonzales@wildlife.ca.gov. Members of the public should be advised to report deer mortalities to both their local biologist, and the Wildlife Investigations Lab via our online mortality reporting form.

https://www.wildlife.ca.gov/Conservation/Laboratories/Wildlife-Investigations/Monitoring/Mortality-Report

Keep in mind that the deer adenovirus is a pathogen specific for white tail and mule deer including black tail deer and does not affect domestic livestock, nor is it a human health risk. However, as is true with any dead animal, people should wear gloves when handling carcasses and domestic dogs should be prevented from scavenging the remains of deer.

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Deer Mortality CAHFS Submissions
2014-2015 as of 7/30/15

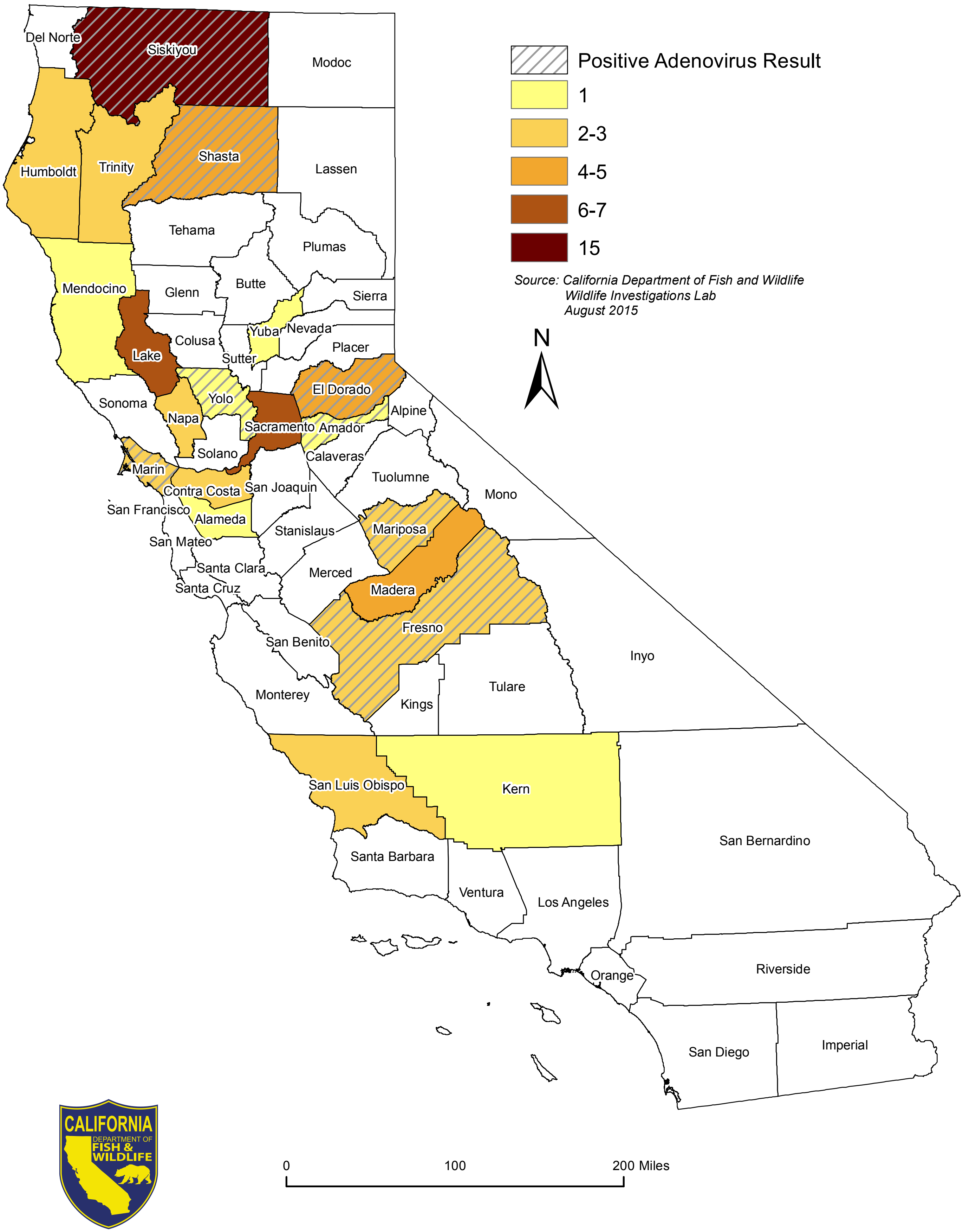

Table 1: Deer Mortalities Submitted to CAHFS (2014-2015) by County with Findings as of 7/30/15								
CAHFS #	**Date**	**Age**	**Sex**	**County**	**Findings**	**Cause of Death**	**AV**	**AV Test**
D1415744	12/23/2014	A	F	Alameda	Pericarditis, endometritis, lung worm infection	Clostridium infection	NT	NA
D1407575	6/19/2014	A	M	Amador	Vasculitis, pulmonary edema	Adenovirus	P	IHC, FA, PCR
D1403672	3/27/2014	J	U	Contra Costa	Pneumonia	Meconium aspiration	NT	NA
D1403672	3/28/2014	J	U	Contra Costa	Alveolitis	Meconium aspiration	NT	NA
D1401770	2/11/2014	A	F	El Dorado	No significant findings due to autolysis	Unknown	NT	NA
D1407790	6/24/2014	A	M	El Dorado	Dermatitis, encephalitis, pneumonia, gunshot	Euthanasia	NT	NA
D1413423	10/28/2014	J	F	El Dorado	Pneumonia, hemorrhagic enteritis	Adenovirus	P	IHC, FA, PCR
D1501183	1/10/2015	J	F	El Dorado	Pneumonia, hemorrhagic enteritis	Adenovirus	P	IHC, FA, PCR
D1505318	3/21/2015	J	F	El Dorado	Pneumonia	Adenovirus	P	FA, IHC
D1400993	1/23/2014	A	F	Fresno	Peritonitis, abomasal abscesses	Cysticercus	NT	NA
D1400997	1/23/2014	A	F	Fresno	Pneumonia, rumenitis, gunshot	Euthanasia	NT	NA
D1412030	9/25/2014	J	F	Fresno	Systemic vasculitis	Adenovirus	P	FA, PCR
D1410922	9/5/2014	J	F	Humboldt	Emaciated	Nutritional	N	FA
D1410922	9/5/2014	J	U	Humboldt	Emaciated	Nutritional	N	FA
T1500057	1/8/2015	A	M	Kern	Pulmonary abscesses, meningeal abscess, dermatitis	Trueperella pyogenes	N	PCR
D1412031	7/4/2014	J	U	Lake	No significant findings due to autolysis	Unknown	N	IHC, PCR
D1412031	7/4/2014	A	F	Lake	Cu deficiency	Unknown	N	FA, PCR
D1409243	7/30/2014	J	F	Lake	Pneumonia, subcutaneous edema	EHD	N	IHC, FA, PCR
D1412288	10/1/2014	A	F	Lake	Meningoencephalitis, pneumonia	Unknown	N	FA, PCR
D1413416	10/27/2014	J	M	Lake	Pulmonary thrombosis, myocardial necrosis, myopathy	Unknown	N	PCR
D1509213	6/26/2015	A	M	Lake	Pleuritis, epicarditis, pneumonia	Trueperella pyogenes	N	FA, PCR
D1407708	6/24/2014	A	F	Madera	Interstitial pneumonia, encephalitis, gunshot	Euthanasia	N	FA
D1411917	9/25/2014	A	M	Madera	Rumen acidosis, encephalitis, gunshot	Euthanasia	N	FA
D1503456	1/14/2015	J	F	Madera	Fractured Skull, fractured Tibia, pneumonia, gunshot	Euthanasia	NT	NA
D1503457	2/5/2015	J	F	Madera	Hepatocellular degeneration, pneumonia	Poss. Heart Failure	N	FA, PCR
D1506855	5/12/2015	J	F	Marin	Colitis	Bacterial	NT	NA
D1509325	7/6/2015	A	F	Marin	Pneumonia	Adenovirus	P	FA, PCR
D1413993	11/10/2014	U	F	Mariposa	Rectal hemorrhage, peritonitis	Trueperella pyogenes	N	FA
D1509811	7/15/2015	J	U	Mariposa	Vasculitis, pulmonary edema, hemorrhagic enteritis	Adenovirus	P	IHC, FA, PCR
D1507833	6/3/2015	A	F	Mendocino	Hemorrhagic enteritis, bronchiolitis, gunshot	Euthanasia	N	FA,IHC
D1410710	8/22/2014	A	M	Napa	Pneumonia, gunshot	Euthanasia	N	FA, PCR
D1410170	9/29/2014	J	M	Napa	Meningoencephalitis, hemothorax, pneumonia	Poss. EHD	N	FA, PCR

CAHFS #	Date	Age	Sex	County	Findings	Cause of Death	AV	AV Test
D1404727	4/22/2014	A	F	Sacramento	Euthanasia drug, dermatitis and poor nutrition	Euthanasia (IV)	NT	NA
D1412431	10/7/2014	A	M	Sacramento	Renal lymphoma, rumen acidosis	Acidosis	N	PCR
D1415529	12/18/2014	J	F	Sacramento	Gunshot	Euthanasia	NT	NA
D1415529	12/18/2014	J	F	Sacramento	Gunshot	Euthanasia	NT	NA
D1415529	12/18/2014	A	F	Sacramento	Gunshot	Euthanasia	NT	NA
D1415529	12/18/2014	A	F	Sacramento	Gunshot	Euthanasia	NT	NA
D1415529	12/18/2014	A	M	Sacramento	Gunshot	Euthanasia	NT	NA
D1402998	3/14/2014	J	M	San Luis Obispo	Pneumonia, nephritis, adrenal hemorrhage	Euthanasia	NT	NA
D1410687	8/28/2014	J	F	San Luis Obispo	Meningitis, adrenal hemorrhage, thrombosis	Listeria encephalitis	N	FA
D1408087	7/2/2014	A	M	Shasta	Pneumonia, pharyngitis, tonsilitis, Se Deficiency	Trueperella pyogenes	N	FA, PCR
D1409795	8/12/2014	A	F	Shasta	Hemothorax, pneumonia, regional vasculitis	Adenovirus	P	FA, PCR
D1410926	9/5/2014	J	U	Shasta	Aspiration pneumonia	Enterobacter cloacae	N	FA
D1410924	9/5/2014	A	M	Shasta	Myocardial necrosis, aspiration pneumonia	Result of aspiration	N	PCR
D1411758	9/10/2014	U	U	Shasta	Myocarditis, myopathy, bronchopneumonia	Hemolytic crisis	N	FA, PCR
D1413566	8/27/2014	U	F	Siskiyou	Peritonitis	Microcystins	NT	NA
D1413568	9/3/2014	U	M	Siskiyou	Interstitial pneumonia, nephritis, hepatopathy	Unknown	N	IHC
D1413564	9/8/2014	U	U	Siskiyou	Bronchopneumonia	Trueperella pyogenes	N	IHC
D1413565	9/10/2014	A	F	Siskiyou	Interstitial pneumonia, tracheitis	Unknown	N	IHC
D1414296	9/26/2014	J	U	Siskiyou	Pharyngitis, esophagitis, glossitis, gunshot	Euthanasia	N	IHC, FA, PCR
D1412723	10/7/2014	A	M	Siskiyou	Encephalitis, kidney edema, gunshot	Euthanasia	N	PCR
D1412728	10/9/2014	J	M	Siskiyou	Nephrosis, rumenitis, myocarditis, gunshot	Euthanasia	N	IHC, PCR
D1413567	10/18/2014	U	M	Siskiyou	Myopathy, pneumonia, gunshot	Euthanasia	N	IHC
D1413563	10/30/2014	A	M	Siskiyou	Pneumonia, rumenitis, mandibular abscess	Unknown	N	IHC, FA, PCR
D1502819	2/19/2015	A	F	Siskiyou	Generalized inflammation, pneumonia, Cu/Se Deficiency	Poss. nutritional	N	PCR
D1502819	2/19/2015	J	F	Siskiyou	Pleuritis, epicarditis, myopathy, Cu/Se Deficiency	Poss. nutritional	N	PCR
D1505165	3/11/2015	A	F	Siskiyou	Emaciated, Cu/Se Deficiency	Nutritional	NT	NA
D1509860	7/16/2015	J	F	Siskiyou	Vasculitis, hemorrhagic enteritis	Adenovirus	P	FA, PCR
D1509860	7/16/2015	J	M	Siskiyou	Vasculitis, hemorrhagic enteritis	Adenovirus	P	FA, PCR
D1509860	7/16/2015	J	U	Siskiyou	Vasculitis, hemorrhagic enteritis	Adenovirus	P	FA, PCR
D1411759	9/23/2014	A	M	Trinity	Myocarditis, rumenitis, hemorrhagic enteritis	Hemolytic crisis	N	FA, PCR
D1412729	10/2/2014	J	F	Trinity	Rumenitis, gunshot	Euthanasia	N	PCR
D1500084	1/5/2015	A	F	Yolo	Vasculitis, pneumonia, hemorrhagic enteritis	Adenovirus	P	IHC, FA
D1400168	1/6/2014	J	M	Yuba	Hepatitis, pneumonia, nephritis, enteritis, trauma	Predation	NT	NA

	A = Adult (>2)		M = Male		IHC = Immunohistochemistry	NT= Not Tested		
	J = Juvenile (<2)		F = Female		PCR = Polymerase Chain Reaction	P = Positive		
	U = Unknown				FA = Fluorescent Antibody	N= Negative		