From:	J. Rose Wallick
To:	Bill Yocum; Chris Lidstone; Chuck Wheeler; Alex Cyril; Jodi Fritts; Glen Hess; Janine Castro; Jay Charland; Linton, Judy L NWP; Lori Warner-Dickason; Jim O"Connor; Patty Snow; Robert Elayer; Todd Confer; Yvonne Vallette
Cc:	rosewall@usgs.gov
Subject:	Umpqua Phase I Synopsis
Date:	Monday, January 05, 2009 10:25:07 AM
Attachments:	Umpqua River Phase I Synopsis-5Jan2009.pdf

Greetings and Happy New Year,

Attached is a brief summary of our findings from the Umpqua Phase I study. This document, along with the supporting figures and graphs, is also available on our FTP site:
ftp://ftpext.usgs.gov/pub/wr/or/portland/oconnor/TechTeamFiles%20Jan%206%202009/

As you all know, the Tech Team meeting will be held at 10:00am Tuesday January 6 at the USGS office. For maps and directions visit:
http://or.water.usgs.gov/location.html

Please let me know if you have any questions about reaching our office,
-
Rose

****
Rose Wallick
Hydrologist
US Geological Survey
Oregon Water Science Center
2130 SW 5th Avenue
Portland, OR 97201
rosewall@usgs.gov
phone: 503-251-3219
fax: 503-251-3470
****

Umpqua River Phase I Synopsis
prepared by Jim O'Connor and Rose Wallick, January, 2009

1. Main activities: In addition to two field reconnaissance trips, we reviewed and assessed:

- historical accounts, photographs, maps and surveys;
- previous hydrology and sediment studies;
- records and surveys from gravel mining operators.

In addition we performed

- specific gage analyses;
- cursory GIS mapping of existing (2005) gravel bars; and
- examination of temporal trends for five bars.

2. Key Findings:

- The semi-alluvial reaches of the Umpqua River system logically divide into six valley segments [**Umpqua Reaches.xls; Umpqua-longitudinal-profile.pdf**] based on geomorphology and hydrology. The mainstem Umpqua is subdivided into the Tidal, Coast Range, and Garden Valley segments; the South Umpqua is divided into the Roseburg and Days Creek segments; and we have identified a single North Umpqua segment encompassing the lowermost 29 miles.
- Historical accounts and information dating back to the 1820s demonstrate that the Umpqua River, aside from the Tidal segment, flowed on bedrock for much of its length. Sand and gravel accumulations were notably sparse.
- The main human activities that have likely had effects on bed material transport and the extent and volume of gravel bars are (1) **intense placer mining activities** (including hydraulic quarrying of alluvium) beginning in the 1850s, especially for tributaries of the South Umpqua River, particularly Cow Creek, Myrtle Creek, Coffee Creek and in the Lookingglass Creek drainage (Historians have stated that these activities produced much gravel that entered the South Umpqua River.); (2) **dam building** on the North Fork Umpqua (Soda Springs dam completed 1952 and blocks downstream bed material transport for 80 percent of the North Umpqua drainage area) and in the Cow Creek drainage (Galesville Reservoir completed 1985, blocking 2.3 percent of the South Umpqua River drainage at the Cow Creek confluence); (3) **in-channel dredging** (Tidal segment) and (4) **gravel mining** from channel flanking gravel bars (primarily in Tidal, Garden Valley, Roseburg and Days Creek segments. The permit history for the period 1970-2010 for some of these activities is summarized in **[combined Umpqua permits.pdf]**. Readily available data for dredging and sand and gravel mining for the Tidal segment is summarized in [**Tidal Reach Sand and Gravel Removal.pdf**].
- There are several sources of historical maps, surveys, and aerial photos that could be used to quantitatively document plan-view changes to river and riparian conditions dating back to the General Land Office surveys of the 1850s. Some information is available, including channel navigation and flood studies, which could be used to quantitatively evaluate changes in channel bathymetry.
- Previous sediment studies conducted for the 1956-1973 water years indicate that 3,500,000 tons/yr of suspended sediment passes the Elkton USGS gage, with the

South Umpqua River contributing more than twice the sediment as the North Umpqua. The major contributor to the South Umpqua is Cow Creek, which produces 2.6 times the sediment as the South Umpqua upstream at Tiller. Bed-material transport rates are likely to be 3-5 percent of the reported suspended loads. Sediment studies in conjunction with FERC relicensing of the Pacific Power project on the North Umpqua indicate pre-dam "reference conditions" transport of 280,000±140,000 tons/yr, and 320,000±160,000 tons/yr under "current conditions." This report suggests that land-use changes have more than compensated for upstream trapping, leading to enhanced sediment transport downstream since impoundment.

- Repeat surveys provided by gravel operators and other sources suggest (1) that extracted volumes are not rapidly replenished in the Tidal segment, with persistent incision indicated by the latest 2002 surveys; and (2) bars in the in Roseburg and Days Creek segments have been rebuilding since last extraction in 2004, especially after high flows in 2005-2006 [**south fork gravel bar surveys.pdf**].
- Reviews of ~35 bridge inspection reports indicate that nearly all bridge piers are set in bedrock. Most show some scour near footings, which typically involves erosion of a thin layer of alluvium, leading to erosion of the underlying bedrock.
- Specific gage analyses for gages on the mainstem (near Elkton), South Umpqua near Brockway, and North Umpqua at Winchester show no or little incision over their periods of record [**Umpqua Ratings.pdf]**. Given the local conditions, the minimal observed incision (less than 0.5 ft) mostly like represents bedrock erosion.
- Systematic mapping of all observable gravel bars for all segments from 2005 aerial photographs [**bar-distribution.pdf**, also summarized in **Umpqua Reaches.xls**] shows that the Tidal segment has by far the greatest area of bare sediment surfaces, but many of these are mud and sand flats, with especially large ones near the mouth of the Smith River. Elsewhere, the Roseburg segment stands out, with 3-4 times the gravel-bar area (on a per river mile basis) of the Coast Range, Garden Valley, and North Umpqua segments; and 1.5 times the area the Days Creek segment. These results point out the much greater bed-material production rates of the South Umpqua River, and in particular the importance of Cow Creek in producing bed sediment.
- Analyses of aerial photograph sequences for five individual bars for 1939, 1967, and 2005 [**BAR AREA ANALYSIS.pdf**] show no clear trends, but extending this analysis for more bars and more time periods would be necessary to determine if trends do exist.

3. Summary statement of findings:

The extensive presence of in-channel bedrock and the relatively few gravel bars in many reaches, historically and currently, are strong evidence that the Umpqua River was and is supply limited. But it is clear that there is much more gravel in the South Umpqua River, especially downstream from the Cow Creek confluence. For most reaches, no trends in channel conditions are evident from the information evaluated so far, although this conclusion is tentative and requires more analysis (for which data is available). The exception is the Tidal segment, for which available data suggests channel incision at least up to 2002. Bed material supply for the Umpqua River system has likely been affected by impoundment, placer mining, and instream gravel mining, although the relative effects of these factors have not yet been determined.

4. Outstanding issues and possible approaches:

- *Bed-material sediment budget.* For the existing distribution of gravel mining operations, it seems that the most useful area for developing a bed-material sediment budget would be for the Days Creek, Roseburg, and Garden Valley segments. The most expedient approaches would probably be a (1) a version of the GIS approach applied for the Deschutes River (developing correlations between physiography, geology, etc. and sediment production; an approach similar to that employed by Stillwater Sciences for the North Umpqua) but here calibrated by the extensive sediment data collected at many sites in the 1950-1970 period and available reservoir surveys; and (2) a modified version of the morphologic approach that would draw upon extensive fieldwork (in order to map the actual area of gravel bars) and existing operator surveys of bar deposition and erosion. This latter approach would be subject to large uncertainties but would be used to judge the reasonableness of the GIS analysis as well as allow an independent assessment of possible temporal trends. It is unlikely that direct measurements of bedload transport for such a supply limited river system would provide much useful information unless conducted for several years.

- *Legacy and ongoing effects of placer mining, impoundments, and instream gravel mining.* A key question, particularly for the South Umpqua River, is how past activities, in particular late 19^{th} century placer mining but also the Galesville Reservoir impoundment, have affected the present gravel flux rates. The most useful approach here would probably be a combinations of (1) temporal analysis by aerial photo mapping of the distribution of areas of active gravel transport for the major streams affected by Placer mining, and (2) reoccupation of cross-sections surveyed in the 1970s for a USGS flood study. Quantitative assessment of gravel budget components attributable to specific activities may be difficult, but trends may be evident.

- *Connections between upstream Umpqua segments and Tidal segment.* Conditions in the Tidal segment owe to upstream sediment supply as well as geologic conditions over the last 10,000 years. The sparse extent and volume of gravel bars (historically and presently) in the Coast Range segment hints that bed-material fluxes have been small over the last few centuries, indicating that gravel from upstream is stored in the Garden Valley segment or is disintegrating downstream. If so, much of the sediment in the Tidal segment may reflect previous geologic conditions or inputs—perhaps enhanced sediment during the millennia after the Mazama eruption. Understanding the relative roles of current, historic, and prehistoric sediment dynamics is necessary to predict the response to the estuary to upstream perturbations. Extending the GIS analysis and morphologic approach to the Coast Range and Tidal segments should aid this understanding, especially if coupled with a new bathymetric survey of the Tidal segment to provide information on recent volumetric changes. This question could also be addressed in part from trends detected in the cross section analysis noted above.

Sediment supply versus transport capacity. The long-term (decades to centuries) evolution of the Umpqua River will depend on the balance between sediment entering and the transport capacity. Both factors have and probably will continue to be affected by dam building, flow regulation, and channel manipulation. Hydraulic modeling of selected reaches will enable estimation of transport capacity and its relation to sediment supply for a variety of future scenarios. A logical first step would be to develop a simple 1D (HEC-RAS) model extending along the Days Creek, Roseburg and Garden Valley Reaches, allowing us to estimate sediment transport capacity for a range of flows. The longitudinal variation in transport capacity can then be compared against estimates of sediment supply and observed locations of erosion and deposition. The purpose of the model is not to directly estimate sediment transport using equations of bedload transport, as such an approach is not suited to the Umpqua because these equations assume unlimited sediment supply, but rather to provide a basis for evaluating the balance between supply and potential transport for various flow and sediment supply scenarios.

From:	Chris Lidstone
To:	Linton, Judy L NWP; Jim O"Connor
Cc:	J. Rose Wallick
Subject:	RE: AGAIN--Re: DEC 22 TECH TEAM MEETING - CANCELED!!!
Date:	Tuesday, January 06, 2009 7:04:13 AM
Attachments:	ORUSG101 Review of USGS Phase 1.doc

Judy:

Attached are my comments. Jim, Rose and I had a lengthy discussion on technical issues and recommended language changes. I have not itemized these issues in the memo but concentrated on the salient issues whcih are relevant what i anticipate will be today's discussion. I understand that Rose and Jim may revisit some of the data and I am going to go back to my notes. Feel free to share my thoughts with the rest of the Tech/Executive Group.

All my best.

Chris

From: Linton, Judy L NWP [mailto:Judy.L.Linton@usace.army.mil]
Sent: Mon 1/5/2009 1:03 PM
To: Chris Lidstone; Jim O'Connor
Cc: J. Rose Wallick
Subject: RE: AGAIN--Re: DEC 22 TECH TEAM MEETING - CANCELED!!!

Unfortunately I will not be able to participate. Chris, can you please send me a brief summary of your comments on the Phase 1 findings and recommendation for an Umpqua Phase 2 study. I'd like to have it for the Tech Team meeting tomorrow if possible. Thanks - Judy

-----Original Message-----
From: Chris Lidstone [mailto:CDL@lidstone.com]
Sent: Saturday, January 03, 2009 7:24 AM
To: Jim O'Connor
Cc: J. Rose Wallick; Linton, Judy L NWP
Subject: RE: AGAIN--Re: DEC 22 TECH TEAM MEETING - CANCELED!!!

Jim:

That works for me. Talk to you then Hope your holidays have been plesant.

Chris

From: Jim O'Connor [mailto:oconnor@usgs.gov]
Sent: Fri 1/2/2009 4:08 PM
To: Chris Lidstone
Cc: J. Rose Wallick; Linton, Judy L NWP
Subject: Re: AGAIN--Re: DEC 22 TECH TEAM MEETING - CANCELED!!!

Chris,

Happy New Year.
Both Rose and I are available Monday afternoon. How about 2 PM Pacific Time.
Judy, let me know if you would like to participate.
We can call both of you from my office.
...Jim

Chris Lidstone wrote:
> Rose:
>
> I have meetings at 9-12 on Monday january 5. Are you available in the
> afternoon?
> Chris
>
> --
> *From:* J. Rose Wallick [mailto:rosewall@usgs.gov]
> *Sent:* Tue 12/30/2008 11:09 AM
> *To:* Chris Lidstone
> *Cc:* Linton, Judy L NWP; Jim O'Connor
> *Subject:* RE: AGAIN--Re: DEC 22 TECH TEAM MEETING - CANCELED!!!
>
>
> Hi Chris and Judy,
>
> Can we schedule the Umpqua teleconference for Monday, January 5th at
> 10:00am? It'd be great to get Chris's comments before our January 6
> Tech Team meeting.
>
> If this works for everyone, then we'll plan on calling each of you
> from our office. Please let us know which number we can reach you at.
>
> We'll post all relevant documents on the ftp site before the meeting.
>
> Thanks,
> -
> Rose
>
>
>
>
> *"Chris Lidstone" <CDL@lidstone.com>*
>
> 12/22/2008 06:59 AM
>
>
> To
> "Jim O'Connor" <oconnor@usgs.gov>
> cc
> "J. Rose Wallick" <rosewall@usgs.gov>, "Linton, Judy L NWP"
> <Judy.L.Linton@usace.army.mil>
> Subject
> RE: AGAIN--Re: DEC 22 TECH TEAM MEETING - CANCELED!!!
>
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>

> Jim:
>
> I've been through that situation (December 2006). Good luck driving-
> it beats the airports anyway. Drive carefully.
>
> Why don't you call or email when you are available? My preference is
> this week but I fully understand. I am in Mon-Wed this week- but will
> be gone all of next week. I will be back in the office on January 5th.
> I have no problem trying to get together next week (week of the 28th)
> but need to work around my cell phone coverage.
>
> Take care.
>
> Chris
>
> --
> *From:* Jim O'Connor [mailto:oconnor@usgs.gov]*
> Sent:* Sun 12/21/2008 9:42 PM*
> To:* Chris Lidstone*
> Cc:* J. Rose Wallick; Linton, Judy L NWP*
> Subject:* AGAIN--Re: DEC 22 TECH TEAM MEETING - CANCELED!!!
>
> Chris, Judy, and Rose;
> I'm stuck in San Francisco (could be worse) and can't get a flight back
> to Portland until Christmas day. So I'm renting a car and driving back
> up tomorrow. Hence, we'll need to put off the call. Could do it Tuesday
> (assuming I get back tomorrow), Wednesday, or next week. Any preferences
> on any of your parts?
> ...Jim
>
>
> Chris Lidstone wrote:
> > Sounds good Jim. 10AM Pacific time. Let me know if you want me to
> > initiate the call or what your plan. I can do up to a 3-way
> > conference. If you want iformation on our FTP site, give my secretary
> > Rita a call on Monday morning at 970 223 4705.
> >
> > --
> > *From:* Jim O'Connor [_mailto:oconnor@usgs.gov_]
> > *Sent:* Fri 12/19/2008 11:20 PM
> > *To:* Chris Lidstone
> > *Cc:* J. Rose Wallick; Linton, Judy L NWP; Jim O'Connor
> > *Subject:* Re: DEC 22 TECH TEAM MEETING - CANCELED!!!
> >
> > Hi Chris,
> > I've talked with Rose about this but forgot to get back to you. How
> > about 10 on Monday? By 9, at the latest, I'll put some figures and a
> > short summary document on a ftp site for you to download.
> > Judy--care to join in? If so, let me know and I can conference you in.
> > It will probably be pretty much a repeat of our discussion with Janine
> > last week.
> > ...Jim
> >
> > Chris Lidstone wrote:
> > > Jim:
> > >
> > > I didn't hear if we (you, Rose and I) are on for Monday. Let me
> know or
> > > if a better time works, also let me know. I will be in Mon-Wed. next
> > > week.

> > >
> > > Chris
> > >
> > > Christopher D. Lidstone
> > > President, Lidstone and Associates, Inc.
> > > 4025 Automation Way, Bldg. E
> > > Fort Collins, CO 80525
> > >
> > > 970 223 4705 office
> > > 970 223 4706 facsimile
> > > 970 420 5257 cell
> > > -----Original Message-----
> > > From: Jim O'Connor [_mailto:oconnor@usgs.gov_]
> > > Sent: Tuesday, December 16, 2008 10:57 PM
> > > To: Chris Lidstone
> > > Subject: Re: DEC 22 TECH TEAM MEETING - CANCELED!!!
> > >
> > > Will do...Jim
> > >
> > > Chris Lidstone wrote:
> > >
> > > >> Sounds good, Jim. Just let me know. You can also call my cell
> phone. I
> > > >>
> > >
> > >
> > > >> will be in meetings all day tomorrow but can get back to you.
> > > >>
> > > >>
> > > >>
> > >
> --
> > >
> > > >> *From:* Jim O'Connor [_mailto:oconnor@usgs.gov_]
> > > >> *Sent:* Tue 12/16/2008 10:37 PM
> > > >> *To:* Chris Lidstone
> > > >> *Cc:* Rose Wallick
> > > >> *Subject:* Re: DEC 22 TECH TEAM MEETING - CANCELED!!!
> > > >>
> > > >> Chris,
> > > >> We could probably do this, depending on weather situation in
> Portland.
> > > >> Also, I need to check with Rose--we're both at AGU this week. But I
> > > >> think we were pretty much ready to go for Monday, so this
> shouldn't be
> > > >> too much of a problem.
> > > >> ...Jim
> > > >>
> > > >> Chris Lidstone wrote:
> > > >>
> > > >>> Jim and Rose:
> > > >>> Apparently Judy has rescheduled the tech team meeting and the
> > > >>> reschedule conflicts with my schedule. I would like to get together
> > > >>> with you on your findings in advance of the Tech team meeting re.
> > > >>>
> > > > the
> > > >
> > > >>> Umpqua. Are you available by phone conference on Monday the 22nd of
> > > >>> December?
> > > >>> All my best.

> > >>> Chris
> > >>>
> > >>>
> > >>>
> > >
> ---
> > >
> > >>> *From:* Linton, Judy L NWP [_mailto:Judy.L.Linton@usace.army.mil_]
> > >>> *Sent:* Tue 12/16/2008 2:54 PM
> > >>> *To:* Alex Cyril; Bill Yocum; Chris Lidstone; Chuck Wheeler; Glen
> > >>> Hess; Janine Castro; Jay Charland; Jim O'Connor; Jodi Fritts;
> > >>>
> > > Linton,
> > >
> > >>> Judy L NWP; Lori Warner-Dickason; Patty Snow; Robert Elayer; Rose
> > >>> Wallick; Todd Confer; Yvonne Vallette
> > >>> *Subject:* DEC 22 TECH TEAM MEETING - CANCELED!!!
> > >>>
> > >>> Hi, All: I have spoken with a couple team members and it was decided
> > >>> given the weather predictions for the coming weekend it's best to
> > >>> cancel the Dec 22nd Tech Team meeting. Most folks I've communicated
> > >>> with are available on January 6 so let's plan on rescheduling for
> > >>>
> > > that
> > >
> > >>> day - same time and hopefully same place. This, of course, is
> > >>>
> > > subject
> > >
> > >>> to the availability of our USGS Teammates as the focus of the
> > >>>
> > > meeting
> > >
> > >>> was going to be a presentation of the Umpqua Phase 1 results.
> > >>>
> > >>> So to sum up: Rescheduled Tech Team meeting will be January 6, from
> > >>>
> > > 10
> > >
> > >>> - 12 at USGS offices. Any changes will be transmitted as soon as
> > >>>
> > > known.
> > >
> > >>> Also, the Corps and DSL have decided to extend the comment period on
> > >>> the RGP/GP public notice. Thought is we will schedule a public
> > >>>
> > > meeting
> > >
> > >>> (probably in March) to allow USGS to present the preliminary results
> > >>> of the sediment transport studies. Meeting will be held in the
> > >>> Brookings area. Chuck suggested it would be good to have a separate
> > >>> meeting for the Tech Team (probably best before this public
> > >>>
> > > meeting).
> > >
> > >>> Again, any suggested dates are all without the benefit of input from
> > >>> the USGS but hopefully will work.
> > >>>
> > >>> Let me know if questions.
> > >>>

> > >>>
> > >> --
> > >> ******NOTE NEW ADDRESS******
> > >>
> > >> Jim O'Connor
> > >> U.S. Geological Survey
> > >> Oregon Water Science Center
> > >> 2130 SW 5th Ave
> > >> Portland, OR 97201
> > >> Phone: 503 251 3222
> > >> Email: oconnor@usgs.gov
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> > >> ******NOTE NEW ADDRESS******
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Jim O'Connor
U.S. Geological Survey
Oregon Water Science Center
2130 SW 5th Ave
Portland, OR 97201
Phone: 503 251 3222
Email: oconnor@usgs.gov

******NOTE NEW ADDRESS******

MEMORANDUM

TO: Judy Linton, Corps of Engineers, Chair Technical Support Team

CC: Jim O'Connor and Rose Wallick, USGS
Joy Smith, Umpqua Sand and Gravel

FROM: Chris Lidstone, Lidstone and Associates, Inc.

DATE: January 6, 2009

SUBJECT: Preliminary Comments on Umpqua River Phase 1 Synopsis

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Judy, the following reflects a brief summary of my preliminary review of the USGS Phase 1 report. I have conveyed more detailed comments to Rose and Jim and recognize that I have had limited time to review the report and data summaries, which were presented with the report. I hope I have the opportunity to join today's discussion.

In summary, I think Jim and Rose did a good job under the limited time frame and available data. I had a number of editorial (word smithing) and technical comments and questions, which I have shared with Jim and Rose. The key issue for today's discussion should be whether this Phase 1 should lead to a Phase 2 and should the Phase 2 encompass only the South Fork or some combination of the North Fork and/or the lower mainstem (Tidal Reach) of the Umpqua. The USGS provided a summary table, which defines the reaches, major factors and general channel trends. Based on my review of the report, the USGS conclusions are that:

(1) Bed material supply has been affected by impoundments, placer mining and instream gravel mining although the relative effects of these factors have not yet been determined;

(2) The majority of active gravel extraction permits are on the South Fork of the Umpqua;

(3) There are significantly more "bars" (105) and more area of gravel bars on the South Fork of the Umpqua than the remaining parts of the river.

(4) In their review of the Garden Valley, Roseburg and Days Creek reaches of the South Fork (RM 100 to 192.4) of the Umpqua, the USGS has concluded that there has been no obvious adverse change to the channel. This is based on their investigation of plan form changes from their inspection of aerial and oblique photos and/or analysis of bar area. They reviewed photos from 1939 to 2005.

(5) The South Umpqua is founded on bedrock and there has been no obvious evidence of channel degradation. The USGS reviewed gage data and bridge inspection reports and concluded that there was minor to no incision.

Lidstone and Associates, Inc.
4025 Automation Way, Bldg E — Fort Collins, CO 80525
(Phone) 970.223.4705 (FAX) 970.223.4706

(6) There is “some evidence of local incision historically near gravel mining operations” within the Tidal Reach. This trend conclusion is based on a 1972 report by CH2M-Hill and personal communication from Janine Castro.

(7) The river system is “supply limited”.

The preliminary information presented by the USGS in their Phase 1 report leads me to conclude that a Phase 2 study of the South Fork of the Umpqua is more than justified. There is (a) obvious permitting interest; and (b) there is no direct evidence of adverse geomorphic impact (degradation, bank erosion or loss of bars) to the South Fork of the Umpqua. I think it is important to define the USGS’s term “supply limited” and this cannot be done without further study.

The remaining questions are whether the Phase 2 study should include the North Fork or the Tidal (mainstem) reach of the Umpqua. With respect to the former, I don’t think there is any basis for us (the Tech Team) to dilute our limited economic resources or time on any further study effort on the North Fork of the Umpqua.

I have recommended to Rose and Jim that they reassess their conclusions or at least the basis for their conclusions on the Tidal Reach. Although I have not reviewed the CH2M-Hill report, that report is 37 years old and may not reflect current conditions and certainly does not reflect the modern permitted (now ceased) mining operation. Secondly I don’t think that personal communication with Janine (or me for that matter) should be a basis for the determination of a channel trend. The USGS did review other technical information in support of their conclusion and I recommended that this information be discussed in their report and cited appropriately.

The fact that LTM has sold their dredge and will not continue mining within the Tidal Reach suggests to me that further studies of the Tidal Reach are an unnecessary expenditure of our limited resources. I continue to feel that it will take a considerable scientific effort to prepare a technically defensible study which will quantify the nexus (temporal, sediment supply volume, sediment delivery ratio) between any proposed South Fork mining withdrawals (RM 110 to 192) and aggradation/degradation trends within the Tidal Reach.

For that reason, I recommend that we authorize the USGS to commence work on a Phase 2 study of the South Fork of the Umpqua. The USGS has laid out an approach under Item 4 of their preliminary report: “outstanding issues and possible approaches”. Although I think all of

Lidstone and Ass
4025 Automation Way, Bldg. E — Fort Collins, CO 80525
(Phone) 970.223.4705 (FAX) 970.223.4706

the approaches have merit, I think the USGS Phase 2 study should adopt critical aspects of the first, second and fourth bulleted “possible approaches”. As noted above, I do not feel that there is a technically defensible (within a reasonable expenditure of funds and time) to quantify the *“connections between upstream Umpqua segments and the Tidal segment”* in a fashion that will assist the agencies in making a permitting decision on gravel extraction along the South Fork of the Umpqua.

I hope my comments help.

Lidstone and Ass
4025 Automation Way, Bldg. E — Fort Collins, CO 80525
(Phone) 970.223.4705 (FAX) 970.223.4706

From:	J. Rose Wallick
To:	Linton, Judy L NWP
Cc:	Jim O"Connor
Subject:	Re: Chetco Data status
Date:	Wednesday, January 21, 2009 3:49:23 PM

Hi Judy,

I had hoped to provide the Chetco datasets by last Friday (1/16), but have clearly missed that deadline. We apologize for the delay.

We have two of the datasets finalized, and nearly ready to post. The estuary bathymetry & 1979/2008 cross-sections have both been prepared and are awaiting final approval from Jim & I before we can post them on the FTP site.

The GIS layers have taken longer than anticipated to finalize. I've been QAQC'ing these datasets, and while everything looks very good, there are a few minor issues that we need to discuss internally before we can distribute the maps. This is basically to ensure that the product we share with the Tech Team is the same product that we use in our analyses & sediment budgets.

At this point, I'm hoping to finalize the GIS datasets by next week and will keep you posted with our progress.

As for the Umpqua, here's where we need guidance:

1). Does the Exec Team want us to investigate linkages between the upstream reaches & the Tidal Reach? If so, then we may want to re-occupy cross-sections in the Roseburg and Garden Valley area that were originally surveyed in a 1979 USGS study.

2). How important is it for us to understand sediment production from various tributaries? If this is important, than we may want to pursue reservoir surveys on the North Umpqua, Cow Creek and possibly other sites in order to quantify sediment yield above the reservoirs. The surveys would also help validate our other GIS-based sediment production analyses.

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The surveys would undoubtedly be expensive, and were not originally budgeted in our Umpqua Phase II proposal. However, we should be able to shift the budget from other tasks (e.g., bedload measurements) to accommodate some level of surveying. But first, we'll need to determine the current level of data availability, get cost estimates from our field office and then prioritize the survey effort according to the budget and objectives.

Feel free to call me or Jim to discuss in more detail. I'll be in the field on Thursday (1/22) but in the office Friday, and Jim should be in all week.

-
Rose

"Linton, Judy L NWP" <Judy.L.Linton@usace.army.mil>

01/21/2009 02:29 PM To
"Jim O'Connor" <oconnor@usgs.gov>, "J. Rose Wallick" <rosewall@usgs.gov>
cc
Subject
Chetco Data status

Hi Jim and Rose – I wanted to check on the status of completing the Chetco River data sets. Do you have an estimate of when they will be available on the ftp site?

Also for the Umpqua River work I have in my notes from the last meeting we had some issues remaining to be decided. They were 1) whether to include the tidal portion in the studies, 2) whether to do HEC/RAS modeling, and 3) whether to include a survey of reservoirs in the system. Do I have that correct and do we owe you an answer next month (February)?

Judy

From:	J. Rose Wallick
To:	Linton, Judy L NWP
Cc:	James E O"connor
Subject:	Chetco release of provisional data
Date:	Monday, February 02, 2009 6:17:24 PM

Hi Judy,

The Chetco River provisional datasets are ready to download from our ftp site. There is a possibility that these datasets may change as we continue our analyses, and as the project undergoes external review. We will notify you if we make any major changes to the datasets.

The link is:
ftp://ftpext.usgs.gov/pub/wr/or/portland/wallick/Chetco/Provisional_Data_release/

The files on the ftp site include:
- Bathymetry maps from 1939 & 2008
- Comparison of cross section data from 1977 and 2008
- Maps of the active channel and bars from 1939, 1943, 1962, 1965, 1995, 2000, 2005 and 2008
- Vegetation maps from 1939, 1962, 1965 and 2008

We are still working on summarizing this data (e.g., graphs showing area of gravel bars, etc over time). We hope to have these graphs prepared in the next few days, and will keep you posted on our progress.

Please let me or Jim know if you have questions about these datasets.

-
Rose

****
Rose Wallick
Hydrologist
US Geological Survey
Oregon Water Science Center
2130 SW 5th Avenue
Portland, OR 97201
rosewall@usgs.gov
phone: 503-251-3219
fax: 503-251-3470
****

From: J. Rose Wallick
To: Linton, Judy L NWP
Cc: James E O"connor
Subject: RE: Chetco release of provisional data
Date: Wednesday, February 04, 2009 5:11:19 PM

Hi Judy,

It would be our preference to make this data publically available for whomever wanted to see it. We're looking into setting up a public website to distribute the provisional data.

So, yes...I suppose you can certainly distribute the datasets to the Technical Team.

Lastly, we decided to simply make data tables summarizing the channel features & vegetation data. There are an infinite number of ways to graph this data, but by making the tables available, folks can create whatever graphs best suit their purposes.

We should be done with the tables tomorrow, and will keep you posted on our progress.
-
Rose

"Linton, Judy L NWP" <Judy.L.Linton@usace.army.mil>

02/03/2009 01:55 PM To
"J. Rose Wallick" <rosewall@usgs.gov>
cc
"James E O'connor" <oconnor@usgs.gov>
Subject
RE: Chetco release of provisional data

Thanks, Rose. Once the data summary graphs have been prepared, would it be okay to release this info to the rest of the Tech Team with the understanding it is provisional? Judy

-----Original Message-----
From: J. Rose Wallick [mailto:rosewall@usgs.gov]
Sent: Monday, February 02, 2009 6:17 PM
To: Linton, Judy L NWP
Cc: James E O'connor
Subject: Chetco release of provisional data

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phone: 503-251-3219
fax: 503-251-3470
****

From:	Fore, Karmen
To:	McCarthy, Molly (Wyden); Bill Yocum
Cc:	Linton, Judy L NWP; Ted Freeman; Jon Isaacs
Subject:	RE: Exec Team mtg - congressional attendance
Date:	Friday, February 06, 2009 11:00:57 AM

Bill;

I have put this on my calendar. For now, I can attend. So you know, this is a congressional in-district work period. I might get called away at some point if called upon by the congressman. I will keep you and Judy posted. Thanks for rescheduling.

Sincerely,

Karmen Fore
District Director
Congressman Peter DeFazio
405 East 8th Avenue, Suite 2030
Eugene, OR 97401
541-465-6732

From: McCarthy, Molly (Wyden) [mailto:Molly_McCarthy@wyden.senate.gov]
Sent: Friday, February 06, 2009 10:30 AM
To: Bill Yocum; Fore, Karmen
Cc: Judy Linton; Ted Freeman; Jon Isaacs
Subject: RE: Exec Team mtg - congressional attendance

Hi Bill – Thank you again for setting this up. It is looking as if I won't be able to make it up there for the meeting. I am wondering, is there a way to be conference in by phone during the meeting?

****

Molly McCarthy Skundrick

Office of U.S. Senator Ron Wyden

Field Representative

Ph: 541-858-5122   Fax: 541-858-5126

From: Bill Yocum [mailto:byocum@hughes.net]
Sent: Friday, February 06, 2009 10:15 AM
To: Karmen; McCarthy, Molly (Wyden)
Cc: Judy Linton; Ted Freeman; Jon Isaacs
Subject: Fw: Exec Team mtg - congressional attendance

Hi Karmen and Molly,

The Congressional Briefing by the Corps, EPA, USFWS, NMFS, DSL, DEQ, ODFW, DLCD, OCAPA has been rescheduled for February 19th. This briefing focuses on the Chetco Pilot Project dealing with sand and gravel supply for the maintenance and improvement of our infrastructure while maintaining the ecological integrity of our environment.

This meeting is currently scheduled in Portland at the Corps Regional Office in the Duncan Plaza beginning at 10:00 am (333 S.W. First Ave. and is also accessed by the MAX Light Rail system which stops directly at the front entrance of Duncan Plaza "Oak Street/SW 1st Ave").

Judy Linton (Corps employee) needs to know if you can make this Congressional Briefing so she can inform Security. Security will make a temporary badge for accessing the meeting. I would be happy to meet you at the 1st Street Security Desk for directing you to the meeting room. If you are available to attend this meeting then please let Judy know. Her email address is Judy.L.Linton@usace.army.mil. Thanks you so much for your hard work in helping to balance our social economic effects with our environmental values. This is what makes us a great country.

Bill

----- Original Message -----

From: Linton, Judy L NWP <mailto:Judy.L.Linton@usace.army.mil>

To: bill yocum <mailto:byocum@hughes.net>

Sent: Tuesday, February 03, 2009 2:14 PM

Subject: Exec Team mtg - congressional attendance

Hi, Bill: wanted to check with you regarding congressional representation at the Executive Team meeting on Feb 19. I know someone from Merkley's office was going to attend but do not have a specific name. I found the message you forwarded to me from Jon Isaacs and will contact him to get the name of the person attending. Do you know if anyone from Wyden or DeFazio's office is confirmed? Thanks for your help - Judy

From:	McCarthy, Molly (Wyden)
To:	Bill Yocum; Karmen
Cc:	Linton, Judy L NWP; Ted Freeman; Jon Isaacs
Subject:	RE: Exec Team mtg - congressional attendance
Date:	Friday, February 06, 2009 10:30:00 AM

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Molly McCarthy Skundrick

Office of U.S. Senator Ron Wyden

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From: J. Rose Wallick
To: Linton, Judy L NWP
Cc: James E O"connor
Subject: RE: Chetco release of provisional data
Date: Monday, February 09, 2009 4:35:32 PM

Hi Judy,

We've finished with the GIS summary, and all files are now uploaded on our FTP site.

ftp://ftpext.usgs.gov/pub/wr/or/portland/wallick/Chetco/Provisional_Data_release/

Please let me know if you have any further questions about this.

I'll keep you posted on the status of a Chetco website where we will post all provisional data for the public.

-
Rose

"Linton, Judy L NWP" <Judy.L.Linton@usace.army.mil>

02/03/2009 01:55 PM To
"J. Rose Wallick" <rosewall@usgs.gov>
cc
"James E O'connor" <oconnor@usgs.gov>
Subject
RE: Chetco release of provisional data

Thanks, Rose. Once the data summary graphs have been prepared, would it be okay to release this info to the rest of the Tech Team with the understanding it is provisional? Judy

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****

From:	Linton, Judy L NWP
To:	"Bob Bailey"; "David Pratt"; Evans, Lawrence C NWP; "Joe Zisa"; "Jon Germond"; "Joy Smith"; "Ken Phippen"; "Kevin Moynahan"; "Kim Kratz"; "Michael Szerlog"; "Monty Knudsen"; "Rich Angstrom"; "Robert Elayer"; "Sally Puent"; "Ted Freeman"
Cc:	"Jay Charland"; "Karmen"; "McCarthy, Molly (Wyden)"; "Jon Isaacs"; Linton, Judy L NWP
Subject:	February 19 Gravel Executive Team Mtg
Date:	Friday, February 13, 2009 12:47:31 PM

A reminder about the Executive Team meeting scheduled for February 19 at the Corps offices in Portland from 12 to 2. We will be meeting in the HDC Conference room on the 8th floor. After you have checked in at the security station for your visitor badge, take the elevators to the 8th floor, take a left off the elevators and then a right at the next hallway – the conference room is on the left side of the hall.

A teleconference line has also been set up for those unable to attend the meeting in person: (888) 296-1938; participant code 731944.

Please let me know if you have any logistical questions. Questions regarding meeting agenda topics should be directed to Kevin Moynahan.

Judy Linton
(503) 808-4382

From: Rich Angstrom
To: Linton, Judy L NWP
Date: Thursday, February 19, 2009 4:23:29 PM

Judy,

Thanks for helping guide us through this morass.

I would like the Tech team to address a few points from today's meeting.

In today's, meeting DEQ addressed their water quality issues with instream gravel removal - one being water temperature degradation from the activity and the other sediment movement coming off of recently mined gravel bars during freshets. The tech committee should be looking at the evidence of temperature impacts from gravel operations especially given the common condition of leaving a foot of gravel above low flow. With regard to sedimentation - I have seen little documentation on this and would ask also for the committee to look at the scientific evidence, studies and permit conditions used to address this concern if valid. I think this last example is a good one for further research.

The last request I would like is when the tech committee reviews and sets permit conditions that they post along with those conditions the reason for it and how it will address concerns over habitat or other fish related impacts. Example: Condition - Apply the instream work window. Reason - to avoid direct impacts to salmon because the work window occurs when salmon are not present.

Thank you.

Richard Angstrom

President

Oregon Concrete & Aggregate Producers Association

737 13th St. SE, Salem, OR 97301

Phone: 503-588-2430 ext.8

Fax: 503-588-2577

From:	CYRIL Alex
To:	Chris Lidstone; Linton, Judy L NWP; Chuck Wheeler; Glen Hess; Janine Castro; CHARLAND Jay; Jim O"Connor; WARNER-DICKASON Lori; SNOW Patty; Rose Wallick; Yvonne Vallette
Subject:	RE: Umpqua River Phase 2 scope
Date:	Thursday, February 19, 2009 9:25:09 AM

Hi Judy.

I don't think a face to face is required. DEQ prefers that all items be undertaken. There has been constant removal from the tidal reaches by both private industry (LTM) and for port dredging over the past several decades and it is invaluable to understand these impacts on the system as a whole. Although we agree that there are complex forces at work, it is critical to understand the system as a whole with as many informational elements as possible. This has been DEQ's position in all discussion to date on this topic.

Thanks.

--Alex

From: Chris Lidstone [mailto:CDL@lidstone.com]
Sent: Wednesday, February 18, 2009 9:50 PM
To: Linton, Judy L NWP; CYRIL Alex; Chuck Wheeler; Glen Hess; Janine Castro; CHARLAND Jay; Jim O'Connor; WARNER-DICKASON Lori; SNOW Patty; Rose Wallick; Yvonne Vallette
Cc: joy@umpquasand.com
Subject: RE: Umpqua River Phase 2 scope

Judy:

i don't know if a face to face is necessary. I would like the USGS (once the below is resolved) to prepare a more detailed approach (scope of work).

Re. Item 1. I do not think it is necessary to investigate the inkages between the upstream reaches and the downstream tidal reach. As I have said before (1) there is no gravel removal (by private industry) proposed in the the tidal reach; (2) there are far too many variables associated with the linkages associated with sediment depostition in the tidal zone; (3) our resources would be better spent on the area of interest/concern.

Item 2. Sediment Production from the tributaries is absolutely essential. This is especially important on the South Umpqua and the effort should concentrate there.

Item 3. Yes. Sediment transport is critical in the South Umpqua Basin. As I recall (and I haven't seen the final Phase 1 report)-- and given that the SOuth Umpqua is a bedrock founded channel and there has not been much noticeable change in planimetric form, I think use of the 1979 cross sections is reasonable approximation for a 1D Steady State Model, as in HEC RAS. The USGS could try to reoccupy several cross sections and see if conveyance capacity remains reasonably close to the 1979 condition. One should recognize that exact reoccupation is unlikely. Also there may be other cross section data available from the mining industry.

Hope this helps.

Chris Lidstone

From: Linton, Judy L NWP [mailto:Judy.L.Linton@usace.army.mil]
Sent: Wed 2/18/2009 4:01 PM
To: Alex Cyril; Chris Lidstone; Chuck Wheeler; Glen Hess; Janine Castro; Jay Charland; Jim O'Connor; Linton, Judy L NWP; Lori Warner-Dickason; Patty Snow; Rose Wallick; Yvonne Vallette
Subject: Umpqua River Phase 2 scope

Folks: at our January tech team meeting we gave the USGS the go ahead to move forward with a couple of tasks as part of a Phase 2 evaluation of the Umpqua River. This included a more in depth aerial photo evaluation and a GIS piece that includes the entire Umpqua Basin.

A few more questions are to be resolved, however. I have pasted a portion of an email from Rose Wallick that describes the guidance USGS needs –

***

As for the Umpqua, here's where we need guidance:

1). Does the Exec Team want us to investigate linkages between the upstream reaches & the Tidal Reach? If so, then we may want to re-occupy cross-sections in the Roseburg and Garden Valley area that were originally surveyed in a 1979 USGS study.

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The surveys would undoubtedly be expensive, and were not originally budgeted in our Umpqua Phase II proposal. However, we should be able to shift the budget from other tasks (e.g., bedload measurements) to accommodate some level of surveying. But first, we'll need to determine the current level of data availability, get cost estimates from our field office and then prioritize the survey effort according to the budget and objectives.

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The Executive Team does not need to be part of the decision-making process regarding the above unless the final scope will exceed the $533K already provided to USGS by the Corps. If funds are expected to be exceeded, we will need to prepare a recommendation to the Executive Team requesting additional funds – the recommendation would need to include a justification for the added cost.

Do you all want to physically meet to discuss the three items listed above or can we resolve by email? If you vote for a face-to-face meeting please suggest a date and time. Thanks - Judy

From:	Patty Snow
To:	Chris Lidstone; Linton, Judy L NWP; CYRIL Alex; Chuck Wheeler; Glen Hess; Janine Castro; CHARLAND Jay; Jim O"Connor; WARNER-DICKASON Lori; Rose Wallick; Yvonne Vallette
Cc:	joy@umpquasand.com
Subject:	RE: Umpqua River Phase 2 scope
Date:	Thursday, February 19, 2009 8:38:56 AM

Hello all, I agree with Chris' response and thought that seemed a reasonable approach. Thanks, Patty

Patty Snow

Land and Water Use Coordinator

Wildlife Division

(503) 947-6089

From: Chris Lidstone [mailto:CDL@lidstone.com]
Sent: Wednesday, February 18, 2009 9:50 PM
To: Linton, Judy L NWP; CYRIL Alex; Chuck Wheeler; Glen Hess; Janine Castro; CHARLAND Jay; Jim O'Connor; WARNER-DICKASON Lori; Patty Snow; Rose Wallick; Yvonne Vallette
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From:	Chuck Wheeler
To:	Chris Lidstone
Cc:	Linton, Judy L NWP; Alex Cyril; Glen Hess; Janine Castro; Jay Charland; Jim O"Connor; Lori Warner-Dickason; Patty Snow; Rose Wallick; Yvonne Vallette; joy@umpquasand.com
Subject:	Re: Umpqua River Phase 2 scope
Date:	Thursday, February 19, 2009 10:27:47 AM

Team: The USGS Phase I synopsis has some intriguing statements about disintegrating gravel, changed geologic conditions, and small influxes of sediment to the reach. However, the USGS acknowledges that they currently do not have enough information to assess the validity of these statements.

The NMFS has a long history in Umpqua discussing our understanding of the impact gravel mining in the South Umpqua has on the upper estuary. If the team chooses not to study the linkage between the South and the estuary, NMFS will rely on the information and logic we have always used. A successful resolution to our current impasse will require an assessment of the linkages between the upper basin and the upper estuary. For NMFS, the question is not whether there is an operator in the lower estuary (besides one could come in anytime and apply), but rather, what is the connection of removing gravel from the system and recovery of the habitat in the upper estuary. If this question is not investigated, then we, as a group, have not dealt with the issue and will not resolve the impasse.

Chuck Wheeler
Fishery Biologist
National Marine Fisheries Service
2900 NW Stewart Parkway
Roseburg, Oregon 97470

Ph. 541.957.3379

Chris Lidstone wrote:

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Subject: Umpqua River Phase 2 scope

Folks: at our January tech team meeting we gave the USGS the go ahead to move forward with a couple of tasks as part of a Phase 2 evaluation of the Umpqua River. This included a more in depth aerial photo evaluation and a GIS piece that includes the entire Umpqua Basin.

A few more questions are to be resolved, however. I have pasted a portion of an email from Rose Wallick that describes the guidance USGS needs –

***

As for the Umpqua, here's where we need guidance:

1). Does the Exec Team want us to investigate linkages between the upstream reaches & the Tidal Reach? If so, then we may want to re-occupy cross-sections in the Roseburg and Garden Valley area that were originally surveyed in a 1979 USGS study.

2). How important is it for us to understand sediment production from various tributaries? If this is important, than we may want to pursue reservoir surveys on the North Umpqua, Cow Creek and possibly other sites in order to quantify sediment yield above the reservoirs. The surveys would also help validate our other GIS-based sediment production analyses.

3). Does the Tech Team want us to evaluate patterns of sediment supply vs transport capacity? If so, then we would likely build a HEC-RAS model to estimate sediment transport capacity for a range of flows. The model would require cross-sections, which we could either take from the 1979 USGS study, or re-survey in 2009.

The surveys would undoubtedly be expensive, and were not originally budgeted in our Umpqua Phase II proposal. However, we should be able to shift the budget from other tasks (e.g., bedload measurements) to accommodate some level of surveying. But first, we'll need to determine the current level of data availability, get cost estimates from our field office and then prioritize the survey effort according to the budget and objectives.

***

The Executive Team does not need to be part of the decision-making process regarding the above unless the final scope will exceed the $533K already provided to USGS by the Corps. If funds are expected to be exceeded, we will need to prepare a recommendation to the Executive Team requesting additional funds – the recommendation would need to include a justification for the added cost.

Do you all want to physically meet to discuss the three items listed above or can we resolve by email? If you vote for a face-to-face meeting please suggest a date and time. Thanks - Judy

EXECUTIVE TEAM MEETING
FEBRUARY 19, 2009
CORPS OF ENGINEERS OFFICES, PORTLAND

* Attendees: Larry Evans and Judy Linton (Corps of Engineers); Kevin Moynahan and Bob Lobdell (OR Department of State Lands); Sally Puent (OR Department of Environmental Quality); Monty Knudsen and Joe Zisa (U.S. Fish and Wildlife Service); Kim Kratz (National Marine Fisheries Service); Michael Szerlog (Environmental Protection Agency); Ted Freeman and Bill Yocum (Freeman Rock, Inc); Joy Smith (Umpqua Sand and Gravel); Rich Angstrom (OCAPA). * By Phone: David Pratt (Curry County Planning); Jon Germond (OR Department of Fish and Wildlife); Jay Charland (OR Department of Land Conservation and Development); Robert Elayer (Tidewater). * Special Guests: Colonel Steven Miles, Kevin Brice, and Erik Petersen (Corps of Engineers); Karmen Fore (Congressman Peter DeFazio's office); and Molly Skundrick (Senator Ron Wyden's office).

1. Opening remarks were made by Kevin Brice (Deputy District Engineer for Project Management). Erik Petersen was introduced to the group – Erik is currently the Operations Project Manager for the Willamette Valley Project, but will be stepping in as the Regulatory Branch Chief when Larry Evans deploys to Afghanistan in March. Colonel Miles also provided some brief remarks to the group. The senior leadership within the Corps expressed appreciation for the willingness of the agencies to be a part of this important effort.

2. Chetco River Status:

* Question: Ted Freeman asked if surveys will be required in 2009 prior to dredging. It will be important to know of any such requirements far enough in advance to allow time to complete surveys prior to the in-water work window. Discussion: The Tech Team has not yet developed any of the final conditions that would be applied to a permit instrument. However, studies, surveys, or monitoring requirements will not be added a permit conditions if they are not necessary to bring impacts to minimal. Several folks indicated their understanding was the USGS studies will provide the baseline information for the 2009 season and therefore, surveys would not be needed. Surveys may, however, be necessary in future years to update the baseline information.

* Rich Angstrom suggested the Tech Team be tasked to begin working on conditions and be prepared to present to the Executive Team.

* Monty Knudsen indicated some of the proposals from the November 2008 joint Corps/DSL public notice raised some red flags for the USFWS; portions of the proposals conflicted with the 'Sediment Removal Considerations Paper'. However, if USGS studies show requirements of the considerations paper are not valid for the Chetco River there is less concern.

* Concerns were expressed by several agencies about the USGS study results and the need to see this information as soon as possible. Judy Linton provided the following status:

- Datasets have been completed and can be provided to the Tech Team.
- Completion of the draft report, which provides interpretation of the data, has slipped. The draft report is now expected in March – the draft report will then go through peer review with the final report available to the public by the end of May.
- Because the draft report is subject to change through peer review, information contained within the report can not be shared with the public per USGS requirements. Industry representatives are considered to be members of the public. The USGS is willing to discuss their preliminary interpretation of the data at an *agency only* meeting to allow evaluation of the Chetco River permit process to move forward. Such a meeting would be appropriate in mid-March.
- Rich raised some concerns with this but in speaking for OCAPA said he was okay with the idea (especially if datasets are released to industry) as it allowed the process to continue. The other participating industry representatives also consented if it meant forward movement.

* <u>Chetco River Key Dates</u>: A final decision will be made by July 15, 2009. If the decision is favorable to further dredging, this decision will be a final signed permit. In order to have the final signed permit on July 15 other necessary permit requirements (final biological opinion, water quality cert, coastal zone consistency) must be in the hands of the Corps by July 14.

3. <u>Umpqua River Status</u>:

- The Phase 1 draft report is complete and is undergoing peer review. The final report should be available for public distribution in March.
- The Tech Team has given the USGS the go ahead to begin some portions of the Phase 2 evaluation (more in depth aerial photo interpretation and GIS evaluation). Several other portions of the Phase 2 scope are being discussed. Completion of the Phase 2 effort is expected by the end of calendar year 2009.
- Work on the development of a regional general permit for the Umpqua River (scope yet to be defined) would occur as part of the Phase 2 effort, but completion of the final product would be set for 2010 prior to the start of the in-water work windows.

4. <u>Follow-up Actions</u>:

- Judy will provide the Chetco River datasets to all members of the Technical Team.
- Judy will schedule an agency-only meeting for mid-March. At this meeting, USGS will present their preliminary interpretation of the results of the Phase 2 studies.

5. Next meeting is scheduled for April 9, 2009 at the DSL offices in Salem (12 to 2:00).

From:	Linton, Judy L NWP
To:	"Alex Cyril"; "Bill Yocum"; "Bob Lobdell"; "Chris Lidstone"; "Chuck Wheeler"; "Glen Hess"; "Janine Castro"; "Jay Charland"; "Jim O"Connor"; "Jodi Fritts"; Linton, Judy L NWP; "Lori Warner-Dickason"; "Patty Snow"; "Robert Elayer"; "Rose Wallick"; "Todd Confer"; "Yvonne Vallette"
Subject:	Chetco River Datasets
Date:	Monday, February 23, 2009 3:24:24 PM

Here is the ftp site where the Chetco datasets are located (if all goes well…). Let me know if you have any issues accessing any of the information.

Please remember the data is provisional and subject to change as USGS writes the draft report and the report goes through the review process.
ftp://ftp.usace.army.mil/pub/nwp/Regulatory%20Gravel%20Initiative/Chetco%20River/

Judy

From:	Linton, Judy L NWP
To:	"Alex Cyril"; "Bob Lobdell"; "Chris Lidstone"; "Chuck Wheeler"; "Glen Hess"; "Janine Castro"; "Jay Charland"; "Jim O"Connor"; "Jodi Fritts"; Linton, Judy L NWP; "Lori Warner-Dickason"; "Patty Snow"; "Rose Wallick"; "Todd Confer"; "Yvonne Vallette"; "joy@umpquasand.com"
Cc:	"Bill Yocum"; "Robert Elayer"
Bcc:	Monical, Teena G NWP
Subject:	Umpqua River Phase 2 scope
Date:	Thursday, March 12, 2009 2:56:40 PM
Attachments:	USGS Phase-II-scope_12Mar09.pdf

This is to confirm we will be gathering via the telephone lines on Monday March 16 from 1:00 to 2:00. Jim O'Connor has prepared an outline of USGS recommendations for the Umpqua River Phase 2 analysis (attached). I don't know of anything specific to discuss regarding the Chetco River so would like to focus the full time on Monday on the Umpqua proposal.

I will be providing the teleconference information once I get the details. Chris – sorry for the short notice; I hope you are able to participate. Joy Smith will be on the call. If anyone can not make the call, but has comments or questions please provide them to me prior to 1:00 on Monday. Thanks - Judy

UMPQUA PHASE II
Proposed Scope of Activities
Jim O'Connor and Rose Wallick
March 12, 2009

Overall Goals [developed from Phase I report and subsequent correspondence with Technical Team members]

1. Develop estimates of sediment supply and budget conditions for each of the six reaches identified in Phase 1 (figure 1; attached table).
2. Evaluate (mostly qualitatively) role of legacy effects of forest practices, dams, and hydraulic mining on current gravel bar and gravel transport conditions.
3. Examine trends and conditions in alluvial deposits for each of the six reaches, but with special emphasis on the Days Creek, Roseburg, and Garden Valley reaches.
4. Compile baseline data to serve as basis for continued system-wide monitoring.

Proposed Approaches [listed in priority, judged on the basis of likelihood to address outstanding questions, cost, and time requirements; all of these activities could be accomplished within present budget and time limitations]

1. GIS-based sediment budget analysis using existing reservoir survey data and 1956-1973 USGS sediment measurements. *Provides estimate of system-wide sediment budget.*
2. Systematic channel mapping from multiple time periods. Along the Days Creek, Roseburg, and Garden Valley reaches, 6 time periods will be mapped and evaluated whereas 3 time periods will be utilized for North Umpqua, Coast Range, and Tidal reaches. Candidate photos sets for complete coverage are available for 1939, 1950, 1967, 1972, 1995, 2000, and 2005. Mapping will include geomorphic floodplain, channel, bedrock outcrops, and gravel bars (denoted as either 'bare' or 'vegetated'). Historical channel maps will also be compiled from the Coast and Geodetic Survey (1854-present), General Land Office (1853-1894) and USGS (1914-1939), from which pertinent information will be digitized. *Allows identification of system-wide trends and conditions, which may be attributable to basin-scale changes or specific disturbance events (floods, mining, dam-building, etc.). These data will also serve as baseline information for future system-wide monitoring and will support the morphologic analysis of transport rates.*
3. Apply modified morphologic approach of estimating sediment flux for the Days Creek, Roseburg, and Garden Valley reaches by looking at changes in gravel bar area with time. The morphologic approach requires relatively short time-intervals, hence 3-4 recent time periods will be utilized. Present volumes will be estimated by field-based sampling of bar thickness. *Provides basis for estimates of reach-specific flux rates, and aids in evaluating trends.*
4. Provenance, particle size, and armoring analyses. Field measurements for approximately 40 bars throughout the study area to evaluate rock types, particle size, and bar armoring. In addition, we will evaluate rock type and particle sizes

for gravel associated with Cow Creek, Myrtle Creek, Lookingglass Creek, Calapooya River, Elk Creek, and Smith River. Both surface and subsurface sampling will be conducted for many bars, and sampling will include both mined and relatively undisturbed bars. *Provides information on sediment source area contributions (critical to understanding the connections between upstream reaches and estuary), armoring, and possible effects of gravel mining on bar composition.*

5. Compilation and analysis of gravel operator survey data, primarily for Days Creek and Roseburg reaches. *Provides information on replenishment rates on disturbed bars, which will aid flux rate calculations from modified morphologic method.*

Other activities that could provide useful information, but that are outside of current budget and timeline constraints [listed in our view of priority, given cost and likelihood of providing relevant information]

1. Cosmogenic analysis of subbasin erosion rates for 6-8 subbasins (University of Oregon). *Provides independent estimate of system-wide sediment budget and augments understanding of rates and locations of sediment contributions. Will be significant test of applicability to future sediment studies.* [This we may try to fit in within existing project]
2. Selected resurveying of 1970s USGS flood-study cross sections. Number and locations of cross sections have yet to be determined, but the survey effort will focus gravel bars in Days Creek, Roseburg, and Garden Valley reaches. *This component would depend on our ability to not only obtain original survey data, but also requires that the original data will be of sufficient precision for us to be reasonably confident we can detect changes. Evaluate possible vertical changes in bar and bed elevation, and provides baseline data for future monitoring. Cross sections could possibly support hydraulic modeling of specific reaches.*
3. Survey bathymetry of the Tidal reach. *Depending on the extent and timing of recent surveys, an updated survey, may indicate rates of sediment accumulation in estuary. Will provide baseline data for future monitoring.*
4. Hydraulic modeling and/or bedload transport rate calculations using established transport relations. *As for the Chetco River, this could provide an indication of potential transport rates, but for Umpqua River system, calculated rates will likely be much higher than actual transport rates.*
5. Bedload transport measurements. *As for the Chetco River, this could provide very valuable information on actual transport rates, but the cost and timing are problematic. Additionally, for a supply-limited system as the Chetco, several measurements would need to made of a course of year to be able to have a reasonable chance to estimate annual flux rates.*

Products.

1. USGS Scientific Investigation Series report summarizing methods, data, and results of all analyses; accompanied by geospatial databases consisting of georectified photomosaics for various photo sets and interpretative mapping.
2. UO Ph.D. thesis [if cosmogenic analysis is conducted]

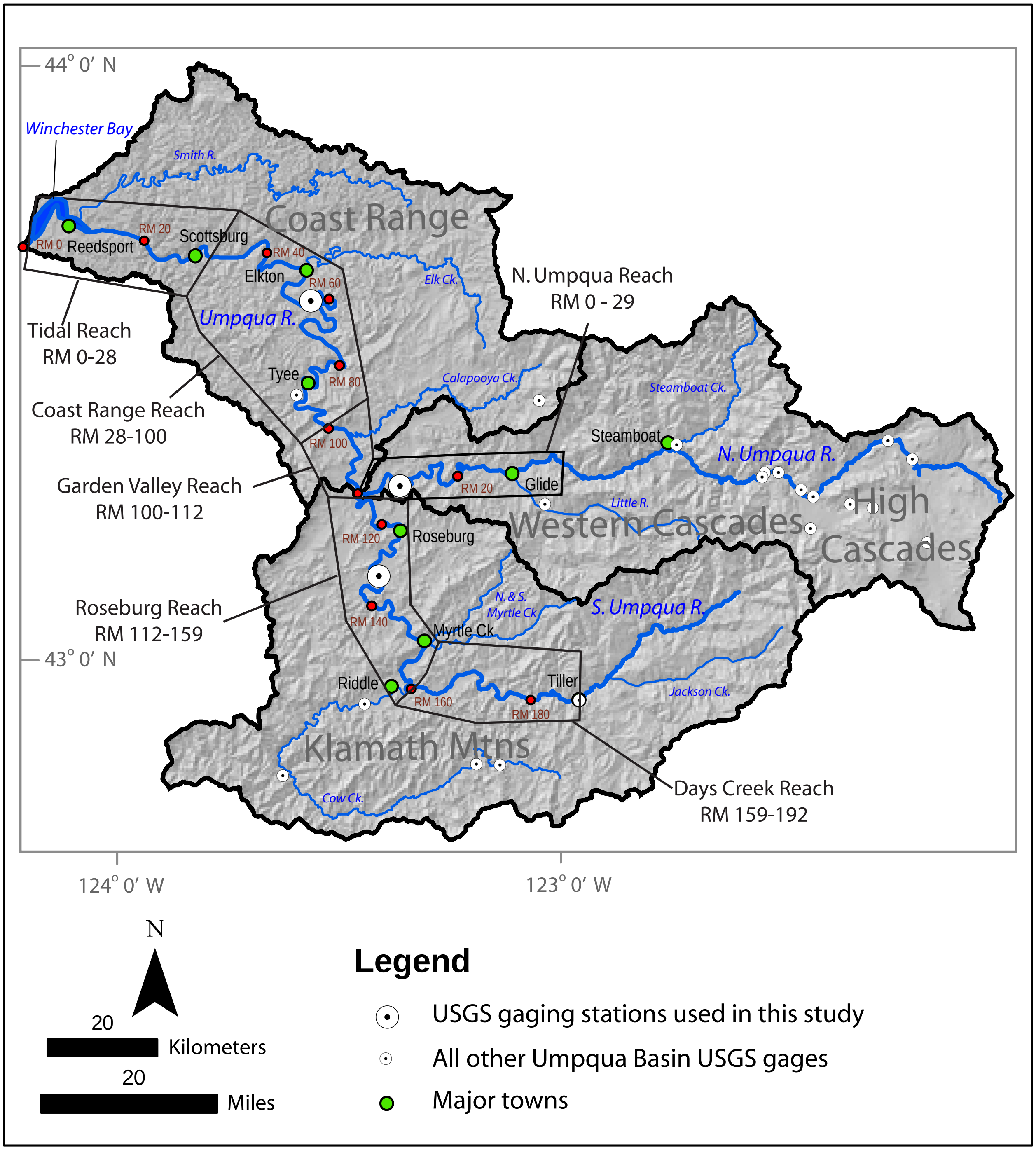

Figure 1. Umpqua River Basin study area in southwestern Oregon, showing location of designated valley segments.

Attribute	Tidal	Coast Range	Garden Valley	Roseburg	Days Creek	North Umpqua
Position	RM 0-27.5	RM 27.5-100	RM 100-111.8	RM 111.8-158.9	RM 158.9-192.4	RM 0-29.0
Reach definition	Tidally affected	Confined valley, bedrock channel	Unconfined below North and South Umpqua confluence	Cow Creek confluence to North Umpqua confluence	Jackson Ck confluence to Cow Creek confluence	Little River confluence to South Umpqua confluence
General Valley Setting	Estuary, confined valley opening to bay within coastal	Confined valley with local valley widenings	Unconfined	Alternating confined and unconfined	Alternating confined and unconfined	Alternating confined and unconfined
General Channel Character	Low gradient, sand and gravel bed	Steep, bedrock rapids separated by flats	Alternating bedrock and gravel	Alternating bedrock and gravel		Mostly bedrock, pool and drop
Area at downstream end of segment in square miles	4,672.7	4,051.1	3,438.0	1,801.6	757.4	1,359.8
Area at upstream end of segment in square miles	4,051.1	3,438.0	3,161.5	1,256.4	435.3	1,216.8
Slope	0.00012	0.00073	0.00098	0.00100	0.00249	0.00177
Number of Bars	5	17	5	72	33	24
Gravel Bars per River Mile	0.07	0.09	0.15	0.55	0.35	0.28
Total Area of Gravel Bars (acres)	22,782.6	91.9	18.7	261.6	123.2	38.9
Average Gravel Bar Area (acres)	4,556.52	5.41	3.75	3.63	3.73	1.62
Gravel area per mile of river (acres/mile)	848.53	1.35	1.53	5.45	3.60	1.25
Major Flow Factors	Tidally affected	Minimal regulation	Minimal regulation	Galesville Reservoir, closed Oct. 7, 1985, regulates 74.3 square miles of Cow Creek basin (5.9% of contributing area at upper end of segment)	None	Pacific Power dams constructed 1952-1955 regulate (slightly) 430 square miles (35% of the area at the upper end of segment)
Major Sedimentation Factors	Change in gradient promotes deposition of bedload and suspended load, Smith River sediment inputs, significant (100,000-500,000 cubic yards per year) sand and gravel	Tributary sediment inputs, local landuse and forest practices	Local sand and gravel mining, forest practices, Calapooya River sediment input	Late 19th century placer mining (Cow Creek, Myrtle Creek, Canyon Creek, and S. Fork), forest practices, sand and gravel mining, tributary sediment inputs	Forest practices, sand and Gravel mining, tributary sediment inputs	Pacific Power dams trap upstream sediment, land-use
Channel Disturbance factors	Historic navigation dredging, sand and gravel mining, rock removal for navigation improvement near Scottsburg, road corridor	Late 19th century navigation improvements, temporary mill dam at Kellogg (removed 1871), road corridor	Late 19th century navigation improvements, Sand and Gravel mining	Local navigation improvements, transportation infrastructure, log driving, sand and gravel mining, placer mining, 19th century mill dams	Transportation infrastructure, sand and gravel mining, log driving (?), placer mining	Navigation improvement log driving, Winchester Dam at RM 7
General Channel Trends	Some evidence of local incision historically near gravel mining operations (CH2M-Hill, 1971; Janine M. Castro, written commun., 2008)	Channel historically and presently on bedrock. Little or no evident change (photos, specific gage analysis for Elkton gage).	Channel historically and presently on bedrock. No obvious change evident from inspection of aerial and oblique photographs, analysis of bar area.	Channel historically and presently on bedrock. No obvious change evident from inspection of aerial and oblique photographs, analysis of bar area, and specfic gage analysis.	Channel locally on bedrock. No evident trends, although limited data for this reach.	Channel historically and presently on bedrock. No evident change from specific gage analysis.

From:	Linton, Judy L NWP
To:	"Chris Lidstone"
Cc:	"Joy Smith"; "MOYNAHAN Kevin"; Petersen, Erik S NWP; Evans, Lawrence C NWP; "Rich@OCAPA.net"
Subject:	RE: Umpqua River Phase 2 scope
Date:	Friday, March 13, 2009 8:26:47 AM

Chris: the concept behind the April 1 meeting was discussed at the last Executive Team meeting and agreed to by both Rich Angstrom and Joy Smith. Background is explained below:

For the Chetco River, USGS can make available to all interested parties the datasets from the Phase 2 study. I made this information available to all members of the Technical Team on February 23rd with the understanding it is still considered provisional and subject to change until the final report is published. USGS can not however provide any interpretation of this data to the public until the report is published - the gravel industry is considered part of "the public".

As you know, the Corps and DSL need to complete the regional general permit/general permit evaluation process by July 2009 based on inwater work windows for the Chetco. This includes ESA consultation, DEQ's water quality certification, and the coastal zone review. We can not afford to wait until the final report is published (sometime late May or early June) to start those review processes. Because of that, USGS agreed to present their interpretation of the data to the regulatory and resource agency members of the Technical Team only. That is the purpose of the April 1 meeting. Both Rich and Joy agreed to allow this meeting to take place especially since the data was made available to all. They also recognize we must move forward with the necessary review processes by other agencies.

I apologize again for any inconvenience caused by the scheduling of the March 16 meeting. I believe I have made every effort possible over the last year plus to accommodate everyone's schedule when setting up meetings. But it is not always possible to get all at the table - there have been several occasions when one or more of the agency representatives could not attend, but we moved forward - so please don't represent to folks that industry is always the one left out. The December/January meeting you referenced was changed based on weather conditions. We rescheduled to the earliest date when most all could attend.

If the Executive Team, based on recommendations by OCAPA and Umpqua Sand & Gravel, want the March 16 meeting to be rescheduled to a future date when all members of the Tech Team can be represented I will do so. The Executive Team must understand, however, that doing so will delay agreements by the Technical Team as to the final scope of the Umpqua River Phase 2 study and as a result could delay the completion of the overall Phase 2 work.

Judy

-----Original Message-----
From: Chris Lidstone [mailto:CDL@lidstone.com]
Sent: Thursday, March 12, 2009 5:40 PM
To: Linton, Judy L NWP
Cc: Joy Smith
Subject: RE: Umpqua River Phase 2 scope

Judy:

OK. Unfortunately this also happened at our December/January meeting and I made significant adjustments to accommodate that last minute schedule modification.

I am concerned based on your email below that I have not been part of the April 1 or even the March 16th discussion until now. If it is the agency's position that the "industry representative" is not sufficiently important to merit inclusion in the planning of meetings than I feel that Joy Smith and OCAPA are wasting their resources in an effort to

keep me involved. My recent experience on providing input and its lack
of reception by the agencies or overall validation has been frustrating.

If you would like to discuss further in advance of the meeting, you can call my cell phone this weekend. I will be at meetings all day Friday and have a hearing on Monday morning. I hope to be available by 1PM your time on Monday.

Christopher D. Lidstone
President, Lidstone and Associates, Inc.
4025 Automation Way, Bldg. E
Fort Collins, CO 80525

970 223 4705 office
970 223 4706 facsimile
970 420 5257 cell

-----Original Message-----
From: Linton, Judy L NWP [mailto:Judy.L.Linton@usace.army.mil]
Sent: Thursday, March 12, 2009 4:37 PM
To: Chris Lidstone
Subject: RE: Umpqua River Phase 2 scope

In arranging the meeting for the agencies and USGS, the afternoon of March 16
was one of the potential dates folks were available. We ultimately settled
on April 1 but I asked them to hold open the 16th should we have a need to
get together. Jim O'Connor was able to complete the SOW outline for phase 2
so I want to take advantage of the 16th to discuss comments folks have related to the SOW.

-----Original Message-----
From: Chris Lidstone [mailto:CDL@lidstone.com]
Sent: Thursday, March 12, 2009 3:07 PM
To: Linton, Judy L NWP
Subject: RE: Umpqua River Phase 2 scope

Judy:

I will try to rearrange my schedule. What is the reason for the short notice?

Christopher D. Lidstone

President, Lidstone and Associates, Inc.

4025 Automation Way, Bldg. E

Fort Collins, CO 80525

970 223 4705 office

970 223 4706 facsimile

970 420 5257 cell

From: Linton, Judy L NWP [mailto:Judy.L.Linton@usace.army.mil]
Sent: Thursday, March 12, 2009 3:57 PM
To: Alex Cyril; Bob Lobdell; Chris Lidstone; Chuck Wheeler; Glen Hess;
Janine
Castro; Jay Charland; Jim O'Connor; Jodi Fritts; Linton, Judy L NWP;
Lori
Warner-Dickason; Patty Snow; Rose Wallick; Todd Confer; Yvonne Vallette;
joy@umpquasand.com
Cc: Bill Yocum; Robert Elayer
Subject: Umpqua River Phase 2 scope

This is to confirm we will be gathering via the telephone lines on
Monday
March 16 from 1:00 to 2:00. Jim O'Connor has prepared an outline of
USGS
recommendations for the Umpqua River Phase 2 analysis (attached). I
don't
know of anything specific to discuss regarding the Chetco River so would
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I will be providing the teleconference information once I get the
details.
Chris - sorry for the short notice; I hope you are able to participate.
Joy
Smith will be on the call. If anyone can not make the call, but has
comments
or questions please provide them to me prior to 1:00 on Monday. Thanks
-
Judy

<<USGS Phase-II-scope_12Mar09.pdf>>

From: Linton, Judy L NWP
To: Linton, Judy L NWP; "Alex Cyril"; "Bob Lobdell"; "Chris Lidstone"; "Chuck Wheeler"; "Glen Hess"; "Janine Castro"; "Jay Charland"; "Jim O"Connor"; "Jodi Fritts"; "Lori Warner-Dickason"; "Patty Snow"; "Rose Wallick"; "Todd Confer"; "Yvonne Vallette"; "joy@umpquasand.com"
Subject: RE: Umpqua River Phase 2 scope: 3/16/09 meeting
Date: Friday, March 13, 2009 3:37:30 PM

Teleconference information is at follows:

Call in number: 1-877-807-5706
Participant code: 751772

Let me know if questions. Judy

-----Original Message-----
From: Linton, Judy L NWP
Sent: Thursday, March 12, 2009 2:57 PM
To: 'Alex Cyril'; 'Bob Lobdell'; 'Chris Lidstone'; 'Chuck Wheeler'; 'Glen Hess'; 'Janine Castro'; 'Jay Charland'; 'Jim O'Connor'; 'Jodi Fritts'; Linton, Judy L NWP; 'Lori Warner-Dickason'; 'Patty Snow'; 'Rose Wallick'; 'Todd Confer'; 'Yvonne Vallette'; 'joy@umpquasand.com'
Cc: 'Bill Yocum'; 'Robert Elayer'
Subject: Umpqua River Phase 2 scope

This is to confirm we will be gathering via the telephone lines on Monday March 16 from 1:00 to 2:00. Jim O'Connor has prepared an outline of USGS recommendations for the Umpqua River Phase 2 analysis (attached). I don't know of anything specific to discuss regarding the Chetco River so would like to focus the full time on Monday on the Umpqua proposal.

I will be providing the teleconference information once I get the details. Chris – sorry for the short notice; I hope you are able to participate. Joy Smith will be on the call. If anyone can not make the call, but has comments or questions please provide them to me prior to 1:00 on Monday. Thanks - Judy

From:	Bill Yocum
To:	rosewall@usgs.gov
Cc:	tedf@hughes.net; mlpmccormick@hughes.net; oconnor@usgs.gov; Linton, Judy L NWP; kevin.moynahan@state.or.us; robert.lobdell@dsl.state.or.us
Subject:	Re: Extraction volume for 2008
Date:	Tuesday, March 31, 2009 8:43:12 AM

Hi Rose,

The aggregate volume that was removed from the Chetco by Freeman Rock during 2008 was 30,089 cubic yards. The survey records that we supplied to the USGS was a copy of the federal removal permit requirements and removal volumes was not a condition. There was another report that was submmitted to the State and they contained the requirement for removal volumes because of recruitment and royalities. If you have any additional question please let us know. Thanks for you help and the excellent work that you have done on the Chetco. When the Chetco Report is available we would appreciate a copy. Thanks again.

Bill Yocum
Freeman Rock Inc.
541-469-2444

On Mar 30, 2009, rosewall@usgs.gov wrote:

Hi Bill & Ted,

Could one of you please provide me the
extraction volume for 2008?

We have looked through the survey records
provided on CD's, but couldn't find actual volumes printed on the CAD files.

Thanks in advance for your help with
this,

-

Rose

****

Rose Wallick

Hydrologist

US Geological Survey

Oregon Water Science Center

2130 SW 5th Avenue

Portland, OR 97201

rosewall@usgs.gov

phone: 503-251-3219

fax: 503-251-3470

****

From:	MOYNAHAN Kevin
To:	bob.bailey@state.or.us; bob lobdell; bill yocum; Petersen, Erik S NWP; jay.charland@state.or.us; joe_zisa@fws.gov; jon.p.germond@state.or.us; joy@umpquasand.com; Linton, Judy L NWP; kevin moynahan; Kim Kratz; Evans, Lawrence C NWP; lori warner-dickason; marcella lafayette; monty_knudsen@fws.gov; Nina Deconcini; SNOW Patty; David Pratt; relayer@twcontractors.com; rich@ocapa.net; PUENT Sally; szerlog.michael@epa.gov; tedf@hughes.net; vallette.yvonne@epamail.epa.gov
Cc:	GEER Kim
Subject:	FW: Gravel Exec team notes
Date:	Friday, April 10, 2009 3:25:04 PM
Attachments:	Gravel notes 4-8-09.doc

All - here are the draft minutes from our meeting. Please let me know if you have any edits.

Thanks, Kevin

April 9, 2009

Gravel Meeting Exec Team 12pm –2:10pm

Attendees:

Name	Affiliation	Email Address
Nina DeConcini	DEQ	mailto:nina.deconcini@state.or.us
Col Steven Miles	COE	Steven.miles@Us.army.mil
Erik Petersen	COE	mailto:erik.s.petersen@us.army.mil
Kevin Moynahan	DSL Assistant Director	Kevin.moynahan@dsl.state.or.us
Bill Yocum	Freeman Rock	byocu@hughes.net
George Edwards	Freeman Rock	gvedwards@hughes.net
Bob Lobdell	DSL	Robert.lobdell@dsl.state.or.us
Kelly Guido	Umpqua Sand & Gravel	kelly@umpquasand.com
Joy Smith	Umpqua Sand & Gravel	joy@umpquasand.com
Judy Linton	COE	Judy.l.linton@usace.army.mil
Rich Angstrom	OCAPA	rich@ocapa.net
Sally Puent	DEQ	Sally.puent@deq.state.or.us

Attendees Telephone Conference:
Monty Knudsen: USFWS
Kim Kratz: NOAA/NMFS
Jay Charland: DLCD
David Pratt: Curry County

Introductions

Agenda:

1. Update on the status of USGS Chetco and Umpqua Investigations:

Colonel Miles met with two different gravel operators at different sites on the Umpqua River. The meeting was very informative and provided insight to the process. The operators would like the state agencies to provide certainty for their projects. Colonel Miles appreciates the full collaboration among all the agencies.

Judy Linton from the COE discussed that Phase II study on the Chetco is now complete. The USGS draft release is scheduled for May 7, 2009. The final public study should be available by late May or early June 2009. Phase 1 of Umpqua study is complete and is posted on USGS website. USGS data collection went smoothly for both the Chetco and the Umpqua studies.

2. Discussion and reinforcement of agency commitments to work ahead using preliminary USGS phase two details on Chetco to make decisions prior to 2009 in-water window.

Kevin Moynahan, DSL, proposes reviewing USGS data before the information is made public - doing this would allow the agencies to get a jump on reviewing the information before the in-water work period.

Rich Angstrom voiced concerns about USGS and the agencies being the only parties that can review the modeling and make the decisions while the industry is excluded on both the executive and technical teams from being involved. Rich thinks it would make sense for USGS to include Chris Lindstrom, a technical expert, as a peer reviewer on the Chetco phase II study.

Joy Smith voiced concerns that Chris Lidstone (consultant), who is an expert on the modeling and the data set, is not being included in technical discussions.

Jay Charland voiced concerns about Chris Lidstone being able to keep the peer review process confidential and not disclose any information to the people who employ him - OCAPA.

David Pratt agreed with Jay Charland, regarding the possible conflict of interest that Chris Lidstone may face.

Nina DeConcini asked questions regarding if USGS would even allow Chris Lidstone as a peer reviewer.

Erik Petersen stated that this process is a partnership with state agencies and stakeholders and has worked well to this point. It is in all parties' interests to continue working collaboratively.

Kevin Moynahan makes a motion that DSL and the COE representative; Erik Petersen will ask USGS at an April 10, 2009 meeting, if it would be acceptable to have Chris Lidstone sit on the peer review committee. Kevin and Erik will discuss the executive gravel teams concerns and also suggest that Janine Castro sit on the peer review group.

Joy Smith seconds the motion

Gravel Exec Team votes and everyone agreed.

Judy Linton said the Tech team would be discussing the result of their prior meeting on 4-22-2009.

Kevin Moynahan and Erik Petersen will attend the next Tech team meeting on 4-22-2009. They want to find out specific information and provide direction from the Exec Team so the teams can work together on meeting timelines.

3. Discussion of where agencies are in relation to review and decision making on the other systems.

Developing studies for other systems will depend on timing and money available. Kevin Moynahan said the funding for other studies is looking bleak this year.

DSL currently has 48 active in-water commercial gravel permits and it intends to continue to issue these permits unless other issues develop.

Erik Petersen talked about the COE developing a process here in Oregon that could be applied to other parts of the country. There is no certainty of additional funds available.

Kevin Moynahan and Rich Angstrom talked about a bill proposal by OCAPA for DSL to receive and use $$ for initial and annual sediment studies.

Bill Yocum suggests that since ODOT will be receiving funding from the government stimulus package to build and improve our roads, that gravel supply will also be needed for materials. Bill suggested asking ODOT if they have $$ to contribute to river studies. Kevin M said he would pursue this issue with ODOT.

Judy Linton said the USGS plans on completing the Umpqua study by the end of summer 2009 but the draft won't be available until March 2010.

Meeting concludes: the next Gravel Exec team meeting is tentatively planned for May 14, 2009 from 12 pm –2 pm at the Portland COE office.

From:	Bill Yocum
To:	kevin.moynahan@state.or.us
Cc:	bob.bailey@state.or.us; bob.lobdell@state.or.us; Petersen, Erik S NWP; jay.charland@state.or.us; joe_zisa@fws.gov; jon.p.germond@state.or.us; joy@umpquasand.com; Linton, Judy L NWP; kim.kratz@noaa.gov; Evans, Lawrence C NWP; lori.warner-dickason@state.or.us; marcella.lafayette@noaa.gov; monty_knudsen@fws.gov; nina.deconcini@state.or.us; patty.snow@state.or.us; prattd@co.curry.or.us; relayer@twcontractors.com; rich@ocapa.net; sally.puent@state.or.us; szerlog.michael@epa.gov; tedf@hughes.net; vallette.yvonne@epamail.epa.gov; kim.geer@state.or.us
Subject:	Re: FW: Gravel Exec team notes
Date:	Saturday, April 11, 2009 9:10:02 AM
Attachments:	Adaptive Management 4_09.doc

Hello Kevin,

A couple of minor corrections on the notes as noted below:
- Under e-mail addresses my correct email is byocum@hughes.net <mailto:byocum@hughes.net> .
- The third paragraph from the end it was George Edwards that suggested dollars might be available from the federal stimulus package through ODOT for funding future studies.

We also had an agenda item titled Adaptive Management that we were going to discuss. Since we ran out of time I mentioned to you that I would write up my concerns and comments. I have attached these. We did not have any opportunity for discussion but by reading this short document you should see were our concerns are coming from. Thanks for you leadership in this great process. It is exciting times that we are experiencing.

Bill Yocum
Freeman Rock Inc.
541-469-2444
541-482-2789

On Apr 10, 2009, kevin.moynahan@state.or.us wrote:

> All - here are the draft minutes from our meeting. Please let me know if you have any edits.
>
> Thanks, Kevin

Adaptive Management

When most resource people think of adaptive management they think of monitoring an on-the-ground operation. Adaptive management also applies to the General Permit/Regional General Permit (GP/RGP) that is currently being developed for the Chetco and Umpqua Rivers.

During the conclusion of the April 8, 2009 OCAPA/DSL Permitting Workshop I heard two very important concepts that were voiced by Kevin Moynahan, Lori Warner-Dickason, Bob Lobdell, Janine Castro, and Judy Linton.

1st dealt with a strong and defensible permit.
2nd Is what I will call the 3 C's (Coordinate, Communicate, and Consistently).

Last Fall Freeman Rock distributed an eight document that listed the permit conditions from Curry County, DSL (with ODFW input) and the Corps of Engineers (with NMFS, USFWS and ODEQ). Six pages of this eight page document contained duplicate and or conflicting permit conditions. Adaptive management can reduce the duplications and conflicts. Last September Freeman Rock received a 60-day Notice of Intent to sue from NEDC that was based on the conflicting conditions. Remember the 3 C's (Coordinate, Communicate, and Consistency) and developing a strong and defensible permit.

The current DSL process for development of permit conditions includes input from ODFW and the proposed action is discussed on-the-ground to mitigate the environment effects why meeting the social needs of aggregate demand. This process has worked quite effective with past removals.

The current Corps process for development of permit conditions includes input from NMFS, USFWS, and ODEQ. The Corps permit then has a condition that requires the permittee to comply with the requirements outlined in the Biological Opinion (BO) and the 401 Water Quality Certification (Cert). This is where the majority of duplication and conflicting conditions reside. A possible solution would be for the resource specialist (Corps, NMFS, USFWS, ODEQ) to function similar to an inter-disciplinary team and streamline their permit conditions directly into the Corps permit and have the BO and the Cert incorporated by reference. This type of approach would be consistent to the DSL process would minimize conflict and duplication.

On April 6, 2009 DEQ issued a Public Notice for the 401 Cert on Freeman Rock's Rogue River operation. The Proposed Action in the Cert conflicted with the Proposed Action listed in the BO that was issued last fall. Remember the 3 C's (Coordinate, Communicate, and Consistency) and developing a strong and defensible permit.

For adaptive management to be effective, we need to apply the 3 C's to monitoring. This will improve resource management and public trust.

The GP/RGP process is and will be under the microscope by our peers and publics. If the process and the developed permit is going to be successful, then it must be defensible. To be defensible it needs to exhibit sustainable resource management. To exhibit sustainable resource management it must be adaptive. To be adaptive, the team (Agencies, Industry and the Public) must apply the 3 C's of Coordination, Communications and Consistency.

We have invested millions of dollars into this process. I believe that this holistic approach of looking at the river systems is the correct approach and we cannot afford to waste dollars by having the decisions based on inadequate staff work. We need to follow the 3 C's and be adaptive in developing a strong and defensible GP/RGP permit.

Bill Yocum
Freeman Rock Inc.
PO Box 1218
Brookings, OR 97415

From: MOYNAHAN Kevin
To: bob.bailey@state.or.us; bob lobdell; bill yocum; Petersen, Erik S NWP; George Edwards; jay.charland@state.or.us; joe_zisa@fws.gov; jon.p.germond@state.or.us; joy@umpquasand.com; Linton, Judy L NWP; kevin moynahan; Kim Kratz; Evans, Lawrence C NWP; lori warner-dickason; marcella lafayette; monty_knudsen@fws.gov; Nina Deconcini; SNOW Patty; David Pratt; relayer@twcontractors.com; rich@ocapa.net; PUENT Sally; szerlog.michael@epa.gov; tedf@hughes.net; vallette.yvonne@epamail.epa.gov
Subject: Adaptive Management 4_09.doc
Date: Monday, April 13, 2009 7:37:17 AM
Attachments: Adaptive Management 4_09.doc

All - Bill Yocum had requested we discuss the issue of adaptive management - as set forth in the attached document - at the Exec team meeting last Thursday.

We ran out of time to have a good discussion on this topic. To get the issue out for consideration I would ask you all to look over Bill's submittal. The focus is on adaptive management and an approach leading to consistency, good communication, and coordination by all parties involved in this process.

Feel free to make comments. We will discuss this issue further as we continue on in this process.

Thanks, Kevin

Adaptive Management

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Bill Yocum
Freeman Rock Inc.
PO Box 1218
Brookings, OR 97415

From:	MOYNAHAN Kevin
To:	CYRIL Alex; LOBDELL Robert; Chuck Wheeler; Jodi Fritts; Glen Hess; Janine Castro; CHARLAND Jay; Linton, Judy L NWP; Lori Warner-Dickason; Jim O"Connor; Rose Wallick; Patty Snow; CONFER Todd A; Yvonne Vallette
Cc:	Petersen, Erik S NWP
Subject:	Message from Gravel Exec team to Tech team regarding the pre-peer reviewed USGS Chetco Study
Date:	Wednesday, April 15, 2009 3:18:14 PM

Tech Team Members:

Over the past couple of years our partnership has been working collaboratively to drive answers about the availability of gravel for extraction on the Chetco. We're reaching a critical milestone with completion of the draft Phase 2 study. As you are aware, this study will be made available in draft form to the agencies so they can begin to understand the analysis and contemplate conditions for an RGP, GP, and 401 cert.

In the spirit of partnership and cooperation, it is imperative that we refrain from absolute conclusions based on the study draft, recognizing two important facts. First, the draft report has not been peer reviewed and may change in substantive ways before it is final. Second, once finalized and released to industry and the public, we must then consider the opinions of our industry partners and the public. To move out conclusively, i.e., to reach final permitting decisions without considering their feedback to the final report would undermine the commitments made by the partners in this gravel initiative.

We strongly encourage your critical review of the draft report and use of it before the final is released. But we must keep an open mind and not reach final conclusions related to permitting until industry has the opportunity to weigh in on the report. The public will also have an opportunity to comment on the report and on the permitting decisions by the local, state and federal agencies involved in this process. In the meantime, we ask you keep an open mind and remain focused on the collaborative process we committed to over two years ago.

Finally, as a reminder, the pre-peer reviewed report and findings therein are not to be discussed or provided outside of the reviewing agencies - unless otherwise agreed to by USGS and in consultation with Erik Petersen and myself - until the report is peer reviewed and made public. During this pre-peer review period reviewing agencies can share with industry initial thoughts and preliminary recommendations concerning authorization conditions (no conclusions as set forth above, and no discussion of the actual draft report findings) and some additional data sets may be released to industry and the public if authorized by USGS.

Thanks for your commitment and hard work on this project.

Erik S. Petersen

Chief, Regulatory Branch

Operations Division

US Army Corps of Engineers, Portland District

333 SW 1st Av

Portland, OR 97204

503.808.4370 (w)

541.510.9024 (c)

Kevin P. Moynahan

Assistant Director

Wetlands and Waterways Division

Department of State Lands

775 Summer Street NE

Salem, OR 97301

503.986.5259

kevin.moynahan@state.or.us <blocked::mailto:kevin.moynahan@state.or.us>

http://www.oregonstatelands.us/ <blocked::http://www.oregonstatelands.us/>

Kevin P. Moynahan
Assistant Director
Wetlands and Waterways Division
Department of State Lands
775 Summer Street NE
Salem, OR 97301
503.986.5259
kevin.moynahan@state.or.us
http://www.oregonstatelands.us/

From:	Linton, Judy L NWP
To:	"Alex Cyril"; "Bill Yocum"; "Bob Lobdell"; "Chip Andrus"; "Chris Lidstone"; "Chuck Wheeler"; "Don Anglin"; "Frank Schnitzer"; "Glen Hess"; "Janine Castro"; "Jay Charland"; "Jim O"Connor"; "Jodi Fritts"; Linton, Judy L NWP; "Lori Warner-Dickason"; "Patty Snow"; "Robert Elayer"; "Rose Wallick"; "Todd Confer"; "Yvonne Vallette"
Cc:	"Bob Bailey"; "David Pratt"; Petersen, Erik S NWP; "Joe Zisa"; "Jon Germond"; "Joy Smith"; "Ken Phippen"; "Kevin Moynahan"; "Kim Kratz"; "Michael Szerlog"; "Monty Knudsen"; "Rich Angstrom"; "Robert Elayer"; "Sally Puent"; "Ted Freeman"
Subject:	Umpqua Phase 1 Report available
Date:	Tuesday, April 21, 2009 8:05:57 AM

Check it out at the following link. Judy

The product is available online at
http://pubs.usgs.gov/ofr/2009/1010/

From:	Jay Charland
To:	Alex Cyril; Bob Lobdell; Chuck Wheeler; Janine Castro; Linton, Judy L NWP; Lori Warner-Dickason; Patty Snow; Rose Wallick; Yvonne Vallette
Subject:	Re: Chetco River monitoring concept
Date:	Thursday, May 07, 2009 1:34:17 PM

I agree with Chuck that LIDAR is a necessity. I also agree that, at least in the early stages of this adaptive management effort, channel profiles should be done more frequently, every year or two, rather than less frequently, every 4-5 years.

For point 3, I am wondering how accurately is precipitation measured in the basin? Is the proposal to measure actual precip at a few points up in the hills, or guess at it by measuring rainfall in town?

Jay Charland | Coastal Permits Coordinator

Oregon Coastal Management Program

Oregon Dept. of Land Conservation and Development

635 Capitol Street NE, Suite 150 | Salem, OR 97301-2540

Office: (503) 373-0050 ext. 253 | Cell: (971) 239-9460 | Fax: (503) 378-6033

jay.charland@state.or.us | www.oregon.gov/LCD

>>> "Linton, Judy L NWP" <Judy.L.Linton@usace.army.mil> 05/07/2009 8:59 AM >>>

As we discussed in our last meeting, attached is a concept of monitoring requirements/data needs to provide information on annual sediment transport in the Chetco. We'll discuss this at our next meeting on May 12 (2 to 4) at the Corps offices. Chuck – if you have an opportunity to review, your comments would be appreciated. Intent is to present this concept to the Executive Team for review and discussion at their meeting on May 14.

Other items on the agenda for Tuesday include:

- Discussion of the draft USGS Sediment Transport report (Rose – are we still on schedule to receive today or tomorrow?)

- Further discussion RGP requirements on describing thresholds, etc.

As always, let me know if questions - Judy

<<Chetco River Gravel_preliminary monitoring req.doc>>

From:	Linton, Judy L NWP
To:	"Alex Cyril"; "Jay Charland"; "Janine Castro"; "Patty Snow"; "WARNER-DICKASON Lori"; "Bob Lobdell"; "Chuck Wheeler"; "Yvonne Vallette"; "Rose Wallick"
Cc:	Linton, Judy L NWP
Subject:	Chetco River monitoring concept
Date:	Thursday, May 07, 2009 8:59:15 AM
Attachments:	Chetco River Gravel_preliminary monitoring req.doc

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As always, let me know if questions - Judy

7 May 2009

Chetco River Gravel: Technical Team Preliminary Concept of Monitoring Requirements/Data Needs – For Executive Team Consideration

Recently the Corps and DSL members of the Executive Team sent an email to the Technical Team regarding the pre-peer reviewed USGS Chetco Study. The email reiterated that USGS released this as a courtesy to the agencies, but that it was not to be shared publicly. While being sensitive to USGS policy, the email also encouraged the Tech Team to share with industry initial thoughts and preliminary recommendations on potential conditions for the RGP/GA currently under consideration.

In continuation of the cooperative approach, the Tech Team offers the following ideas from our on-going discussions as an update which industry may have interest in considering.

The RGP/GA concept offers a unique opportunity to revisit data needs and monitoring requirements on a broader, systemwide scale. Site specific surveys that occur multiple times per year have been previously required in individual permits as a mechanism for documenting removal volumes and interpreting potential impacts. Unfortunately, this site specific information is not adequate for detection of reach or systemwide changes and is onerous on individual applicants both in effort and cost expended (applicants report annual costs of $15,000 to $20,000).

The USGS approach to the Phase II Chetco study has provided a useful overview of the Chetco River system. The Tech Team agrees that building on this study with similar data collection efforts over time will enable refinement of the interpretations and effective future adaptive management. Additionally, the Tech Team believes that a shift away from individual surveys in favor of systemwide evaluations will ameliorate expense and effort on individual operators who can, instead, pool resources to acquire broader data. These data will provide better opportunity for interpretation of systemwide adjustments, while also being much less expensive.

Preliminary Tech Team discussions regarding on-going data acquisition include:

1. Annual LIDAR flights along the entire lower Chetco system (~RM 0-12).
    - Relatively inexpensive, high quality topographic data – cost figures from the current DOGAMI LIDAR acquisition are ~$549/square mile, which translates to ~$6000/yr for the lower Chetco.
    - At low water, LIDAR would capture riffle crests, but lack pool filling information and other habitat specific biological indicators.

2. Longitudinal profiles of the channel thalweg for the lower Chetco (~RM 0-12) every 2 to 5 years.

- Provision of more specific information on individual pools and other biological indicators, as well as ground-truthing of elevational changes.
- This could be accomplished over the course of a couple of days by a qualified contractor with costs ranging from ~$6000 to $15,000 every 2 to 5 years.

3. Annual stream flow analysis utilizing gage data, recorded precipitation, and other applicable information to more accurately estimate annual sediment transport rates.

- Costs should be minimal given that the models are already constructed; data from the previous year can be input into the existing models to predict annual transport rates.

While the Tech Team agreed that a systemwide approach is both more desirable and economically feasible, we also recognize that there still must be a standard method for confirming actual volumes extracted at individual sites; whether this can be determined with sufficient accuracy from the proposed LIDAR data sets or another on the ground measure needs further determination.

As noted in the Public Notice for the RGP/GA, Adaptive Management has been called out as an appropriate mechanism for making year to year determinations on potential gravel removal volumes and methods. Establishment and funding of an agency led body to house and analyze the above data sets, so that adaptive determinations based on the collected body of data can be made, will be an important component of a successful RGP/GA.

From:	LOBDELL Robert
To:	Linton, Judy L NWP
Cc:	WARNER-DICKASON Lori
Subject:	RE: Chetco River monitoring concept
Date:	Thursday, May 07, 2009 11:21:35 AM

looks good judy. The only 'edit' I see is the RGP-GP process, not GA. Thanks

---

From: Linton, Judy L NWP [mailto:Judy.L.Linton@usace.army.mil]
Sent: Thursday, May 07, 2009 8:59 AM
To: Alex Cyril; CHARLAND Jay; Janine Castro; SNOW Patty; WARNER-DICKASON Lori; Bob Lobdell; Chuck Wheeler; Yvonne Vallette; Rose Wallick
Cc: Linton, Judy L NWP
Subject: Chetco River monitoring concept

As we discussed in our last meeting, attached is a concept of monitoring requirements/data needs to provide information on annual sediment transport in the Chetco. We'll discuss this at our next meeting on May 12 (2 to 4) at the Corps offices. Chuck – if you have an opportunity to review, your comments would be appreciated. Intent is to present this concept to the Executive Team for review and discussion at their meeting on May 14.

Other items on the agenda for Tuesday include:

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As always, let me know if questions - Judy

<<Chetco River Gravel_preliminary monitoring req.doc>>

From:	Chuck Wheeler
To:	Linton, Judy L NWP
Cc:	Alex Cyril; Jay Charland; Janine Castro; Patty Snow; WARNER-DICKASON Lori; Bob Lobdell; Yvonne Vallette; Rose Wallick
Subject:	Re: Chetco River monitoring concept
Date:	Thursday, May 07, 2009 10:08:42 AM

Thanks for this opportunity, sorry (not really) that I can't call in next week. Here are my thoughts:
1. The Lidar is a necessity. My agency is a little cautious about not having annual full-channel topography, but we are on-board with the reach scale monitoring.
2. The longitudinal profiles will help considerably with the shortcomings of the LIDAR in #1. I have an issue with leaving this open to a 2-5 year range though. Especially in the beginning I believe a shorter period (2 years) is needed. If we leave it open to a 2-5 year period, it will always be 5 years. We need to develop criteria that trigger the need for a profile, potentially a change in the LIDAR information or some channel characteristic.
3. No comment

Annual volume - The Lidar will be flown (I am assuming) prior to any harvest. While it may be a baseline to measure back to, some survey will be required to calculate the volume removed post-harvest. It could be another small Lidar flight, or on the ground survey, but some other survey will be required post-harvest.

Review group - I see this as mandatory, not important as you wrote.

Thanks everyone!

Chuck Wheeler
Fishery Biologist
National Marine Fisheries Service
2900 NW Stewart Parkway
Roseburg, Oregon 97470

Ph. 541.957.3379

Linton, Judy L NWP wrote:

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<<Chetco River Gravel_preliminary monitoring req.doc>>

From:	Jay Charland
To:	Linton, Judy L NWP
Subject:	Re: Chetco Monitoring Req - revised
Date:	Wednesday, May 13, 2009 12:57:41 PM
Attachments:	Chetco River Gravel_prelim monitoring req_ver2.charland.doc

Some notes.

Jay Charland | Coastal Permits Coordinator

Oregon Coastal Management Program

Oregon Dept. of Land Conservation and Development

635 Capitol Street NE, Suite 150 | Salem, OR 97301-2540

Office: (503) 373-0050 ext. 253 | Cell: (971) 239-9460 | Fax: (503) 378-6033

jay.charland@state.or.us | www.oregon.gov/LCD

>>> "Linton, Judy L NWP" <Judy.L.Linton@usace.army.mil> 05/13/2009 9:43 AM >>>

Here is the revised monitoring document based on our discussions yesterday. If you have a chance, please take a look and make sure I have captured things correctly. I want to send this out to the Executive Team, along with meeting particulars, this afternoon. Comments by 2:00 today would be appreciated.

Also, we need to schedule another Tech Team meeting – what do schedules look like for either the week of May 25 or June 1?

Judy

<<Chetco River Gravel_prelim monitoring req_ver2.doc>>

7 May 2009

Chetco River Gravel: Technical Team Preliminary Concept of Monitoring Requirements/Data Needs – For Executive Team Consideration

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The RGP/GAP concept offers a unique opportunity to revisit data needs and monitoring requirements on a broader, system-wide scale. Site specific surveys that occur multiple times per year have been previously been required in individual permits as a mechanism for documenting removal volumes and interpreting potential impacts. Unfortunately, this site specific information is not adequate for detection of stream reach or system-wide changes, and is onerous on individual applicants both in effort and cost expended (applicants report annual costs of $15,000 to $20,000).

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Preliminary Tech Team discussions regarding on-going data acquisition include:

1. Annually conduct two LIDAR flights (one in June/July and one in Sept/Oct) along the entire lower Chetco system (~RM 0-12). If no material is removed from the system, conduct one flight in June/July.
    - Purpose is to measure sediment recruitment and removal, and overall channel conditions.
    - Relatively inexpensive, high quality topographic data – cost figures from the current DOGAMI LIDAR acquisition are ~$549/square mile, which translates to ~$6000/yrflight for the lower Chetco.

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- At low water, LIDAR would capture riffle crests, but lack pool filling information and other habitat specific biological indicators.

2a. Conduct ~~L~~longitudinal profiles of the channel thalweg for the lower Chetco (~RM 0-12) ~~every 2 to 5 years~~ after two years with peak flows of ~10,000 cfs or after one year with a peak flow of ~~~20~~45,000 cfs.
2b. Conduct point bar analysis during same years as longitudinal profiles.

- Provision of more specific information on individual pools and other biological indicators, as well as ground-truthing of elevational changes.
- This could be accomplished over the course of a couple of days by a qualified contractor with costs ranging from ~$6000 to $15,000 ~~every 2 to 5 years~~.
-

3. Annual stream flow analysis utilizing gauge data~~, recorded precipitation,~~ and other applicable information to more accurately estimate annual sediment transport rates.

- Costs should be minimal given that the models are already constructed; data from the previous year can be input into the existing models to predict annual transport rates.

4. Annually conduct bedload sampling at the USGS streamflow gaging station (one site visit per year).

- Purpose is to evaluate reliability of the model and establish site specific bedload transport curve. Takes away the uncertainty of the model.

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While the Tech Team agreed that a system-wide approach is both more desirable and economically feasible, we also recognize that there still must be a standard method for confirming actual volumes extracted at individual sites; whether this can be determined with sufficient accuracy from the proposed LIDAR data sets or another on the ground measure needs further determination.

As noted in the Public Notice for the RGP/G~~A~~P, Adaptive Management has been called out as an appropriate mechanism for making year to year determinations on potential gravel removal volumes and methods. Establishment and funding of an agency~~-~~-led body to house and analyze the above data sets, so that adaptive determinations based on the collected body of data can be made, will be an important component of a successful RGP/G~~A~~P.

From: CYRIL Alex
To: Linton, Judy L NWP
Subject: FW: Chetco Monitoring Req - revised
Date: Wednesday, May 13, 2009 10:06:26 AM
Attachments: Chetco River Gravel_prelim monitoring req_ver2.doc

---

My suggestions tracked...

--Alex

From: Linton, Judy L NWP [mailto:Judy.L.Linton@usace.army.mil]
Sent: Wednesday, May 13, 2009 9:44 AM
To: CYRIL Alex; WARNER-DICKASON Lori; LOBDELL Bob; SNOW Patty; CHARLAND Jay; Janine Castro
Cc: J. Rose Wallick; Jim O'Connor
Subject: Chetco Monitoring Req - revised

Here is the revised monitoring document based on our discussions yesterday. If you have a chance, please take a look and make sure I have captured things correctly. I want to send this out to the Executive Team, along with meeting particulars, this afternoon. Comments by 2:00 today would be appreciated.

Also, we need to schedule another Tech Team meeting – what do schedules look like for either the week of May 25 or June 1?

Judy

<<Chetco River Gravel_prelim monitoring req_ver2.doc>>

7 May 2009

Chetco River Gravel: Technical Team Preliminary Concept of Monitoring Requirements/Data Needs – For Executive Team Consideration

Recently the Corps and DSL members of the Executive Team sent an email to the Technical Team regarding the pre-peer reviewed USGS Chetco Study. The email reiterated that USGS released this as a courtesy to the agencies, but that it was not to be shared publicly. While being sensitive to USGS policy, the email also encouraged the Tech Team to share with industry initial thoughts and preliminary recommendations on potential conditions for the RGP/GAP currently under consideration.

In continuation of the cooperative approach, the Tech Team offers the following ideas from our on-going discussions as an update which industry may have interest in considering.

The RGP/GAP concept offers a unique opportunity to revisit data needs and monitoring requirements on a broader, systemwide scale. Site specific surveys that occur multiple times per year have been previously required in individual permits as a mechanism for documenting removal volumes and interpreting potential impacts. Unfortunately, this site specific information is not adequate for detection of reach or systemwide changes and is onerous on individual applicants both in effort and cost expended (applicants report annual costs of $15,000 to $20,000).

The USGS approach to the Phase II Chetco study has provided a useful overview of the Chetco River system. The Tech Team agrees that building on this study with similar data collection efforts over time will enable refinement of the interpretations and effective future adaptive management. Additionally, the Tech Team believes that a shift away from individual surveys in favor of systemwide evaluations will ameliorate expense and effort on individual operators who can, instead, pool resources to acquire broader data. These data will provide better opportunity for interpretation of systemwide adjustments, while also being much less expensive.

Preliminary Tech Team discussions regarding on-going data acquisition include:

1. Annually conduct two LIDAR flights (one in June/July and one in Sept/Oct) along the entire lower Chetco system (~RM 0-12). If no material is removed from the system, conduct one flight in June/July.
   - Purpose is to measure sediment recruitment and removal, and overall channel conditions.
   - Relatively inexpensive, high quality topographic data – cost figures from the current DOGAMI LIDAR acquisition are ~$549/square mile, which translates to ~$6000/~~yr~~flight for the lower Chetco.
   - At low water, LIDAR would capture riffle crests, but lack pool filling information and other habitat specific biological indicators.

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7 May 2009

2a. Conduct Llongitudinal profiles of the channel thalweg for the lower Chetco (~RM 0-12) every 2 to 5 years after two years with peak flows of ~10,000 cfs (several years could pass before this occurs) or after oneany year with a peak flow of ~2045,000 cfs.
2b. Conduct point bar analysis at locations from USGS study during same years as longitudinal profiles.

- Provision of more specific information on individual pools and other biological indicators, as well as ground-truthing of elevational changes.
- This could be accomplished over the course of a couple of days by a qualified contractor with costs ranging from ~$6000 to $15,000 every 2 to 5 years.
-

3. Annual stream flow analysis utilizing gage data, recorded precipitation, and other applicable information to more accurately estimate annual sediment transport rates.

- Costs should be minimal given that the models are already constructed; data from the previous year can be input into the existing models to predict annual transport rates.

4. Annually conduct bedload sampling at the USGS streamflow gaging station (one site visit per year).

- Purpose is to evaluate reliability of the model and establish site specific bedload transport curve. Takes away the uncertainty of the model.

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While the Tech Team agreed that a systemwide approach is both more desirable and economically feasible, we also recognize that there still must be a standard method for confirming actual volumes extracted at individual sites; whether this can be determined with sufficient accuracy from the proposed LIDAR data sets or another on the ground measure needs further determination.

As noted in the Public Notice for the RGP/GAAP, Adaptive Management has been called out as an appropriate mechanism for making year to year determinations on potential gravel removal volumes and methods. Establishment and funding of an agency led body to house and analyze the above data sets, so that adaptive determinations based on the collected body of data can be made, will be an important component of a successful RGP/GAAP.

From:	Jim O"Connor
To:	Linton, Judy L NWP
Cc:	CYRIL Alex; WARNER-DICKASON Lori; LOBDELL Robert; Patty Snow; Jay Charland; Janine Castro; J. Rose Wallick
Subject:	Re: Chetco Monitoring Req - revised
Date:	Wednesday, May 13, 2009 10:00:31 AM

Hi Judy,
This looks good. One thing--I thought that about 45,000 cfs would be the trigger requiring a longitudinal survey in the following summer. This is about the 5-yr flow. A 20,000 cfs trigger would require longitudinal surveys 8 out of 10 years.
...Jim

Linton, Judy L NWP wrote:
>
> Here is the revised monitoring document based on our discussions
> yesterday. If you have a chance, please take a look and make sure I
> have captured things correctly. I want to send this out to the
> Executive Team, along with meeting particulars, this afternoon.
> Comments by 2:00 today would be appreciated.
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> schedules look like for either the week of May 25 or June 1?
>
> Judy
>
> <<Chetco River Gravel_prelim monitoring req_ver2.doc>>
>

--
******NOTE NEW ADDRESS******

Jim O’Connor
U.S. Geological Survey
Oregon Water Science Center
2130 SW 5th Ave
Portland, OR 97201
Phone: 503 251 3222
Email: oconnor@usgs.gov

******NOTE NEW ADDRESS******

From:	MOYNAHAN Kevin
To:	bob lobdell; bill yocum; Petersen, Erik S NWP; George Edwards; BAILEY Bob (Bob.Bailey@state.or.us); CHARLAND Jay (Jay.Charland@state.or.us); joe_zisa@fws.gov; Jon Germond; joy@umpquasand.com; Linton, Judy L NWP; kevin moynahan; Kim Kratz; Evans, Lawrence C NWP; lori warner-dickason; marcella lafayette; monty_knudsen@fws.gov; Nancy Johnson; Nina Deconcini; SNOW Patty; David Pratt; relayer@twcontractors.com; rich@ocapa.net; PUENT Sally; szerlog.michael@epa.gov; tedf@hughes.net; vallette.yvonne@epamail.epa.gov
Cc:	thehomecountry@onemain.com
Subject:	FW: Elk River Gravel Study
Date:	Friday, July 17, 2009 1:47:22 PM

All - for your consideration - please see below e-mail from Cameron La Follette at Oregon Shores re the Elk River.

Enjoy the weekend.

Kevin

From: Cameron La Follette [mailto:thehomecountry@onemain.com]
Sent: Friday, July 17, 2009 11:38 AM
To: MOYNAHAN Kevin
Subject: Elk River Gravel Study

Hi Kevin,

I would appreciate it if you would share this email with other members of the interagency Gravel Executive Team, either at their next meeting or via email.

Oregon Shores has long been concerned about instream gravel mining in some of the coast's best salmon rivers. One of our principal concerns at this time is the proposal to mine gravel from the Elk River. Tidewater Sand and Gravel, as agents for the Wagner family, proposes to mine 12,000 cubic yards from the river under a 1987 Curry County permit. Tidewater submitted an application to the Corps of Engineers, which is pending; and a hearing before the Curry County Board of Commissioners on the Wagner permit is scheduled for Tuesday, July 21st.

My understanding is that the Gravel Team has a list of rivers for which first and second phase studies will be done to determine sedimentation budgets and geomorphology. I am aware that the second phase study for the Chetco is nearly done, and that for the Umpqua is due in December of this year. My understanding is that the next rivers in line for study (when funds become available) are the Rogue, Tillamook, Coquille and Willamette/McKenzie. The Elk, being smaller, is at the very end of this list.

I understand why the Elk is the caboose of the study list—it is so small compared with large systems like the Rogue or Willamette. But on the other hand, the Elk contains some of the very best salmon habitat in the state. NMFS, in its letter to DSL about its gravel permit renewal for the Elk in 2008, specifically mentioned the SONCC coho run on the Elk as being a key population necessary to boost or renew poor runs on other rivers. The Chetco's population is very depressed. The Elk's population is robust because both the mid and upper watersheds are protected in wilderness, and the river itself in most of its reaches is also protected.

Given the Elk's importance as the river with the healthiest population of SONCC coho, which are listed as Threatened under the Endangered Species Act, might the Gravel Team consider focusing on a search for funding to study the Elk soon? As last on the list, it would presumably not be studied for at least three years or so, unless funding suddenly became available. But since there is now a controversial proposal to mine gravel from the Elk, the need for knowledge of the river's gravel budget is pressing. The SONCC coho in the Elk are very important, both ecologically and economically. They are also federally protected.

It is impossible to make appropriate decisions about instream gravel mining, especially on a sensitive river like the Elk, without good scientific data. Oregon Shores would like to encourage the Gravel Team to consider the Elk as a high-priority river on which to fund studies as soon as possible.

Thank you for your time.

Sincerely,

Cameron La Follette
Land Use Director
Oregon Shores Conservation Coalition

From:	Petersen, Erik S NWP
To:	Ellis, Karla G NWP; "Kevin.Moynahan@state.or.us"; Linton, Judy L NWP; "lori.warner-dickason@state.or.us"; "jay.charland@state.or.us"
Subject:	Next Exec Team - Public Involvement at Sep Workshop?
Date:	Friday, July 17, 2009 10:24:10 AM

Guys - I sent this yesterday and again this morning but my blackberry said it did not go, so I'm resending...

I'm glad to discuss the issue of public involvement at the exec team meeting - but I have some thoughts.

I appreciate our intent to drive transparency - my sense is that the depth and breadth of our meeting would be further complicated by trying to expand the audience. We have much work to be done. If we add more new players or complicate communication dynamics, our process gets harder and less efficient.

I'm not comfortable inviting add'l stakeholders in at this point, but I'm not dogmatic about excluding them either. If we want to seriously consider, let's thoroughly weigh downside risks and ask ourselves how we'll manage them.

Thanks for opening up dialogue on the matter.

esp

Message sent via my BlackBerry Wireless Device

From:	Linton, Judy L NWP
To:	"gail.achterman@oregonstate.edu"
Subject:	FW: Gravel Tech Team mtg
Date:	Monday, August 10, 2009 3:03:53 PM
Attachments:	Chetco project specific issues 5Aug09.doc Tech Team Mtg agenda 080509.doc

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Gail: forwarding particulars regarding the Technical Team meeting scheduled for Wednesday August 12 at the Corps offices. Call-in information included within email below. Let me know if questions. Judy

-----Original Message-----
From: Linton, Judy L NWP
Sent: Thursday, August 06, 2009 10:37 AM
To: Linton, Judy L NWP; 'CYRIL Alex'; 'Chuck Wheeler'; 'Patty Snow'; 'Yvonne Vallette'; 'LOBDELL Robert'; 'Janine Castro'; 'Jay Charland'
Cc: 'WARNER-DICKASON Lori'; 'J. Rose Wallick'; 'Jim O'Connor'
Subject: RE: Gravel Tech Team mtg

Folks -

Two documents attached for our meeting on the 12th:
1. Agenda
2. Chetco River Issues document - this document is primarily a 'cut and paste' of extraction methods and potential conditions from the November 2008 Corps/DSL public notice and the 13 May 2009 Monitoring Requirements/Data Needs recommendation paper prepared by the Tech Team. This document also identifies some issues that need to be resolved regarding adaptive management and removal thresholds.

Please review document 2 and come to the meeting prepared to discuss the following:
a. Each agency identify methods of operation or other issues that are deal killers.
b. Each agency identify methods of operation or other issues that need revision.
c. Create a list of issues that need to be discussed related to adaptive management and gravel removal thresholds.

Here are the conference line particulars for those needing to participate by phone: USA Toll-Free: (888)296-1938; PARTICIPANT CODE: 333343

Do folks want to have a USGS presence at the meeting to assist in any questions we may have? Rose has indicated she is more than willing to participate if we would like - provided the baby stays put for awhile longer!

Let me know if questions. Judy

-----Original Message-----
From: Linton, Judy L NWP
Sent: Thursday, July 23, 2009 4:07 PM
To: 'CYRIL Alex'; 'Chuck Wheeler'; 'Patty Snow'; 'Yvonne Vallette'; 'LOBDELL Robert'; 'Janine Castro'; 'Jay Charland'
Cc: 'WARNER-DICKASON Lori'; Linton, Judy L NWP
Subject: RE: Gravel Tech Team mtg

Looks like the best day for the most folks is August 12th - let's plan on meeting from 1-3; I'll have a phone line for those needing to call in. Lori and I will prepare some info (proposed conditions, thresholds, etc) and provide to all before the meeting to get the discussions going. Judy

CHETCO RIVER
Project Specific Issues to Address

EXTRACTION METHODS

- Bar Removal. Sand and gravel removal would be located on large gravel bar adjacent to the river channel. The width, depth, and cross section shape would be based on adjacent river channels. (A Typical Diagram of the Bar Removal Technique is shown on Figure 5).
    a. Head of bar. Protect the upper 1/3 of the bar from any excavation activities.
    b. Lateral Buffer. The area between the low flow channel and the active mining area would be one foot elevational difference. Buffer widths (horizontal distance) will be set based on site specific conditions.
    c. Excavated length. The lower 2/3 of the gravel bar would be shaped with a slope towards the river plus a slope towards the downstream direction of the river.
    d. Excavated head slope. This portion of the excavated area would be no steeper than 10:1 (horizontal to vertical).

- Horseshoe. Horseshoe construction would be located on large gravel bar adjacent to the river channel. The width, depth, and cross section shape would be based on adjacent river channels. (A Typical Diagram of the Horeshoe Construction method is shown in Figure 6).
    a. Head of bar. Protect the upper 1/3 of the bar from any excavation activities.
    b. Lateral buffer. The set-back area between the low flow channel and the active mining area will be set based on site specific conditions.
    c. Excavated backwater length. Maximum excavated backwater length is 2/3 of the total length of the bar feature.
    d. Excavated backwater area. The area of the excavated backwater would be constrained by the established buffers except on the lower end where it would be designed to breach with over-topping during the fall and winter freshets. The depth of the backwater bottom would be above the low water level except for a narrow deep channel. This narrow deep channel would have a width of less than 10% of the width of the bar. The maximum depth of the narrow deep channel would be the same as the deepest part of the active river channel. The length of the narrow deep channel would have a maximum excavated length of 1/2 of the bar feature.
    e. Excavated backwater head slope. This portion of the excavated backwater area would be no steeper than 10:1 (horizontal to vertical).
    f. Excavated side slopes. This portion of the excavated backwater area would be no steeper than 4:1 (horizontal to vertical).

- Alcove. Alcove construction would be located on the downstream end of the North Fork Chetco Gravel Bar (see the Freeman Bar Location Map, Figure 1). The purpose would be to increase vertical structure or diversity to this reach of the river while relieving the hydrologic pressures of the confluence from the North Fork of the Checto with the mainstem of the River. The width, depth, and cross section shape will be based on the adjacent river channel. The maximum depth will be the same as the deepest part of the active river channel. The excavated side slopes will be no steeper than 4:1 (horizontal to vertical); the shape would curve along the alignment of the old channel. The downstream buffer of the alcove will have a portion that is designed to breach when over-topping occurs during the fall and winter freshets.

- Backwater or trench construction. The width, depth, and cross section shape would be based on adjacent river channels. The maximum depth would be no deeper than the deepest part of the active river channel. (A Typical Diagram of the Backwater/Trench Construction Method is shown in Figure 7).
  a. Lateral buffers. The set-back area between the low flow channel and the active mining area would be no less than 20 feet from the active channel. Other lateral buffers may be set based on site specific conditions.
  b. Excavated backwater length. Maximum excavated backwater length would be within 20' of the head of bar.
  c. Excavated backwater area. The area of the excavated backwater would be constrained by the established buffers except on the lower end where it would be designed to breach with over-topping during the fall and winter freshets.
  d. Excavated backwater head slope. This portion of the excavated backwater area would be no steeper than 4:1 (horizontal to vertical).
  e. Excavated side slopes. This portion of the excavated backwater area would be no steeper than 4:1 (horizontal to vertical).

- Small ponds. Two small ponds of approximately three acres each could be constructed near the high-water mark on the south side of upper Freeman Bar (see Freeman Bar Location Map, Figure 1). Because of the elevation/location of these small ponds the location would be on lands where DOGAMI and DSL both have jurisdiction. Volume removed would be around 20,000 CY per pond.

  The intent is to use this method only during times of extreme drought periods, when the annual return of sand and gravel is not adequate to supply the needs of the local communities. The ponds would be constructed well away from the wetted channel and as such would not interfere with low flow habitat. The maximum depth would be the no deeper than the deepest part of the active river channel. The shape would curve along the alignment of the old channel. Excavated side slopes would be no steeper than 4H:1V and any vegetation cleared during construction of the ponds would be placed in the ponds.

- Pit Extraction behind Protective Berm. This method has been used at Tidewater's estuary site for over 35 years. The general procedure is to construct a protective berm during low tide events on the river side of the extraction site. The berm is at a height sufficient to keep water from flowing into the extraction area during high tide events. Once the berm is in place, the extraction process can take place safely, even during tidal fluctuations. The area behind the protective berm is dug to a depth no deeper than the deepest part of the river channel. After the extraction is complete and the turbidity in the pool settles, the berm is removed and the pit is opened to the river at both ends.

  This described extraction plan is similar to the backwater or trench construction method. The excavation is confined to the lower 2/3 of the gravel bar length where naturally occurring alcoves generally form. These alcoves provide a deep, slow water refuge for juvenile salmonids during moderate to high velocity flows.

MONITORING REQUIREMENTS

- Monitoring during construction.

1. Vehicle staging areas will be designated for cleaning, maintenance, refueling, and monitoring for petroleum leaks and repairs. This staging area will be no closer than 150' from any water. All equipment will be cleaned before starting the removal season. Daily inspection will be preformed on all vehicles for fluid leaks. Any leaks detected will be repaired before leaving the staging area to perform removal activities. Documented inspections will be logged in a record that will become part of the post-harvest report.

2. Established photo points with pictures being taken once a week during the removal season. The photo points with pictures will become part of the post-harvest report.

3. Turbidity monitoring will be conducted and recorded every four hours either visually or with a turbidimeter during the removal operations. (*Specific turbidity monitoring requirements will be developed as part of the RGP process and are expected to be contained in any water quality certification issued by the Oregon Department of Environmental Quality*).

4. A post-harvest report will be completed by the end of December following the removal season.

- Monitoring for Adaptive Management.

1. Annually conduct two LIDAR flights (one in June/July and one in Sept/Oct) along the entire lower Chetco system (~RM 0-12). If no material is removed from the system, conduct one flight in June/July.
(**Does this replace the following?** A pre-harvest (spring) and post-harvest (fall) survey will be conducted by the operator.)

- Purpose is to measure sediment recruitment and removal, and overall channel conditions.
- Relatively inexpensive, high quality topographic data – cost figures from the current DOGAMI LIDAR acquisition are ~$549/square mile, which translates to ~$6000/flight for the lower Chetco.
- At low water, LIDAR would capture riffle crests, but lack pool filling information and other habitat specific biological indicators.

2a. Conduct longitudinal profiles of the channel thalweg for the lower Chetco (~RM 0-12) after two years with peak flows of ~10,000 cfs (several years could pass before this occurs) or after any year with a peak flow of ~45,000 cfs.

2b. Conduct point bar analysis at locations from USGS study during the same years as longitudinal profiles are taken.

- Provision of more specific information on individual pools and other biological indicators, as well as ground-truthing of elevational changes.
- This could be accomplished over the course of a couple of days by a qualified contractor with costs ranging from ~$6000 to $15,000.

3. Annual stream flow analysis utilizing gage data and other applicable information to more accurately estimate annual sediment transport rates.

- Costs should be minimal given that the models are already constructed; data from the previous year can be input into the existing models to predict annual transport rates.

4. Annually conduct bedload sampling at the USGS streamflow gaging station (one site visit per year).

- Purpose is to evaluate reliability of the model and establish site specific bedload transport curve. Takes away the uncertainty of the model.

Adaptive Management and Removal Thresholds (Issues for resolution)

- Identify areas of degradation for monitoring. Determine the recovery goal in terms of streambed elevation or bar stabilization.
- Determine the target recruitment rates to achieve recovery.
- Using historical recruitment data or modeling information, determine threshold recruitment rates that would allow for some extraction.
- Determine the percentage of recruited material that could be extracted and still allow for recovery.
- Using annual bedload sampling make a determination the cubic yards of material that can be removed for any given year.

GENERAL CONDITIONS (keep a running list as discussions progress)

1. Removal operations will be limited to the daylight hours.

2. No removal of vegetation will occur outside the designated work area on gravel bars. The only removal of vegetation will be for operational reasons.

3. During removal operations, gravel bars will be constantly graded and sloped to avoid fish entrapment.

4. Pollution and Erosion Control Plans. Such plans may require following Best Management Practices to minimize pollution from being introduced into the river. Such BMPs may include:

   - Sequence/Phasing of work – work will be scheduled so as to minimize potential turbidity in the water.
   - Equipment control – all excavation and relocation of material by machinery will be completed so as to minimize turbidity.
   - Machinery will not drive into the active flowing channel except for one crossing to place a temporary bridge and one crossing for the removal of the temporary bridge.
   - Excavated material will be placed so that it is isolated from the water edge and not placed where it could re-enter the river or natural drainage to the river.
   - Use of containment measures such as silt curtains, geoblocks, geotextile fabric, and silt fence will be implemented where needed and properly maintained to minimize instream sediment suspension and resulting turbidity.

5. Mitigation for anticipated adverse impacts?

Tech Team Mtg
August 12, 2009
Agenda

1. Chetco Updates and old business:

    a. USGS Study

    b. Workshop

    c. RGP and GP status

    d. Public Meeting for USGS study briefing? Early September?

2. Specifics of the RGP and GP (identification of issues to address). Group review and discussion of Chetco specific issues (attached).

    a. Each agency identify methods of operation or other issues that are deal killers.
    b. Each agency identify methods of operation or other issues that need revision.
    c. Create a list of issues that need to be discussed at the workshop related to adaptive management and gravel removal thresholds.

3. Next steps, next meeting

From:	Linton, Judy L NWP
To:	"Bob Bailey"; "David Pratt"; "Joe Zisa"; "Jon Germond"; "Joy Smith"; "Ken Phippen"; "Kevin Moynahan"; "Kim Kratz"; "Michael Szerlog"; "Monty Knudsen"; "Rich Angstrom"; "Robert Elayer"; "Sally Puent"; "Ted Freeman"; "gail.achterman@oregonstate.edu"
Cc:	"Alex Liverman"; "Bill Yocum"; "Bob Lobdell"; "Chip Andrus"; "Chris Lidstone"; "Chuck Wheeler"; "Janine Castro"; "Jay Charland"; "Jim O"Connor"; "Jodi Fritts"; Linton, Judy L NWP; "Lori Warner-Dickason"; "Patty Snow"; "Rose Wallick"; "Todd Confer"; "Yvonne Vallette"; Monical, Teena G NWP; Hanson, Michele E NWP
Subject:	FW: Chetco Report available
Date:	Monday, August 10, 2009 2:53:43 PM

Forwarding the link for the Chetco River Phase 2 study results. Jim O'Connor and Rose Wallick will provide a summary of the study results at tomorrow's Executive Team meeting.

I will be sending the link to the interested public participants via a separate email. Judy

-----Original Message-----
From: Jim O'Connor [mailto:oconnor@usgs.gov]
Sent: Monday, August 10, 2009 12:52 PM
To: Linton, Judy L NWP
Cc: J. Rose Wallick; oconnor@usgs.gov
Subject: Chetco Report available

Hi Judy,
The report is available at:
http://pubs.usgs.gov/of/2009/1163/
Sorry for the last-minute timing.
...Jim

--
Jim O'Connor
U.S. Geological Survey
2130 SW 5th Ave
Portland, OR 97201
Phone: 503 251 3222
email: oconnor@usgs.gov

From:	Bill Yocum
To:	kevin.moynahan@state.or.us
Cc:	bob.lobdell@state.or.us; Petersen, Erik S NWP; gvedwards@hughes.net; imceaex-_o=dsl_ou=salem1_cn=recipients_cn=bob+20bailey@dsl.state.or.us; imceaex-_o=dsl_ou=salem1_cn=recipients_cn=jay+20charland@dsl.state.or.us; joe_zisa@fws.gov; jon.p.germond@state.or.us; joy@umpquasand.com; Linton, Judy L NWP; kim.kratz@noaa.gov; Evans, Lawrence C NWP; lori.warner-dickason@state.or.us; marcella.lafayette@noaa.gov; monty_knudsen@fws.gov; nancy.johnson@noaa.gov; nina.deconcini@state.or.us; patty.snow@state.or.us; prattd@co.curry.or.us; relayer@twcontractors.com; rich@ocapa.net; sally.puent@state.or.us; szerlog.michael@epa.gov; tedf@hughes.net; vallette.yvonne@epamail.epa.gov
Subject:	Re: FW: Gravel Exec Team Minutes 8/11/09 (2nd attempt)
Date:	Tuesday, August 18, 2009 10:00:55 AM
Attachments:	Bills edits to Gravel Exec Team Meeting Minutes 081109[1].doc

Hello Kevin,

Good job on the notes. I have 3 minor comments on the attached notes. Thanks again for working to improve our rivers and our State.

Bill

On Aug 17, 2009, MOYNAHAN Kevin <kevin.moynahan@state.or.us> wrote:

Attached are draft minutes from the Exec team meeting last week. Please send me any edits - thanks, Kevin

Gravel Exec. Team Meeting Minutes

8/11/09 12:00 – 2:00 PM

Attendees: Kevin Moynahan (DSL), Bob Lobdell (DSL), Lori Warner-Dickason (DSL), Sally Puent (DEQ), Patty Snow (ODFW), Jay Charland (DLCD), Erik Petersen (COE), Bill Yocum (Freeman Rock), Ted Freeman (Freeman Rock) Terrence Conlon (USAS), Joy Smith (Umpqua Sand), Jon Germond (ODFW), Judy Linton (COE), Jim O'Connor (USGS), Rose Wallick (USGS), Richard Angstrom (OCAPA), Robert Elayer (Tidewater Contractors)

Comment [Bill1]: I believe that Terrence is with the USGS

Teleconference Attendees: Janine Castro (FWS), David Pratt (Curry Co.), Kim Kratz (NMFS), Scott Clemans (COE-PA)

Primary Objective: Review the summary document findings from the USGS Chetco Phase 2 report.

1. **Review USGS Chetco Phase 2 Release Report:**
   - Main focus was on summary document of findings (handout).
   - Speaker Jim O'Connor drafted the report. Refer to Rose Wallick with questions.
   - Objective of study: to understand volume of gravel coming in and historic changes that occurred.
   - Study components: area spanned lower 18 km of Chetco River corridor and USGS streamflow gage station, primarily upstream (RM 10.7, Fig. 1).
   - Study 1) mapped valley floor and changes to the channel, gravel bars, and floodplains, 2) throughout the study bed material sediments were characterized, 3) bed material fluxes were quantified and transport trends were evaluated, and 4) results were compared against from studies in nearby basins.
   - Findings: Results were consistent, decrease in area of active gravel bar areas from 1965 to 1995. Approximately no change since 1995. Low flow channel has dropped (pg. 35).
   - Coast is made up of a variety of rock types making a gravel rich system.
   - 20,000 years ago sea level was 400 ft lower. After ice age the water level rose drowning the mouths of rivers faster than the rate of gravel coming in.
   - Sediment budget shows flux rates are consistent with other studies. In absence of gravel extraction, most bed material entering is historically deposited near North Fork of Chetco River (50,000 – 130,000 cubic yards per year). Approximately 80,000 cubic yards per year is extracted. 5-30% is lost to attrition and breakdown. Very little gravel exports thru Chetco River estuary of natural causes. USGS is confident numbers are accurate by factor of 2.
   - Incision estimated to have occurred in late 70's. (pg. 36, Fig. 20 shows trends of bed elevation).
   - Other finding: Gravel bar's texture coarsens toward North Fork surface. Increase of sediment in supply, decrease of sediment transport in lower. Biggest changes were years 1965 to 1995. Two factors: 1) 1964 flood increased sedimentation in lower river; 2) gravel extraction (rates higher 70's - 80's). Both likely play a part.

Comment [Bill2]: I believe that Rose and Jim along with Scott Anderson and Charles Cannon all drafted the report.

Comment [Bill3]: The period of greatest positive change (more deposition than erosion) were in 1962-1965 and 2005-2008 (pg. 70).

- USGS estimate was done around Christmas to New Years '08. Recorded second highest rate ever measured in literature of sediment influenced per feet.
- River is not supply limited. Measured each of 39 years since.
- Jim brought in a 15 lb. sample of Quartzite rock (approximately 8"x5"x3") found by 6"x12" opening in collection box. Quartzite resists breakdown due to density.
- <u>Purpose:</u> Sediment transport model will help to determine future years using USGS gage and flow data.

Q: If we monitor year to year, what would increase confidence level?
A: more than 2, track with time.
Q: Do studies/findings transfer to other river systems?
A: With steep coastal rivers, yes. With larger Umpqua & Cascades, no. Supply limited. Will vary, though same approach can be applied.
Q: What triggers "limited supply"?
A: Enough sediment depends on movement, usually how much is produced, steep drainage ditch breaks up, quick increase flow can transport.

- Look at incoming vs. spending, about even. Incoming amount is @ 0 – 100,000 cubic yards per year so have to decide if we measure every 1 year, 3 years, etc.

Q: Material down river is incoming? If all activity were ceased would the river spread back to normal? Does down river transport effect estuary?
A: Transport equation looked at 7 places: down river had small amount of sediment transport (1/5 or 1/10 of upstream). Studies of other estuaries (Redwood Creek, Alsea, and Nestucca) are looking at type of sediment, most dredging from Marine sources.

- No resolution of data where dredging was occurring, can't say what part of estuary. At RM 2.1, annual basis did replenish 100%.
- Concern: reduces habitat quality (less oxygen available)
- Issue: With increased bed level also increased water level. Area has been channel incized since 1967. Some pools/bars move, some areas now vegetated trailer parks. Residents are worried about possible flooding.
- There is no current scale or way to classify river.
- (Kevin & Erik) Thanks to COE, USGS for report, attendance at meeting, effort, and explaining report findings in simple terms.
- (Erik) Responsible extraction can be met with the help of the study. No answers yet but we have a process of moving forward.
- Umpqua schedule: report coming out (hopefully) Spring 2010, draft possibly in February? Drafts are internal (not public info). Would like to know of other deadlines ahead of time if something may be affected.
- Survey data and extraction records help speed up the process. Technical team spoke about using Lidar (high priority), OGAMI is coordinating.
- Annual flow data & Lidar survey will not be enough. Flow data is broad scale of river interest. Repeat measurements, sediment texture measurement. Surveys might not be accurate. Upside to Lidar is it's high quality and done by one person.

- Approaching post 1964 condition of flood vs. impact would be a mute point. Don't know income of 1964. Track balance of in vs. out. If we continue a program of measuring and it balances, overall changes will be small.
- (Rose) Formatting of report will be complete when goes to SIR but public report is available on Chetco's website including data, aerial photos, GIS, etc. Rose can email info if requested.
- (Kevin) Will want to gather direct conversations and info shared. More structure is needed to answer permit questions.
- (Kevin) Tech team will take USGS Report and permit questions to be resolved (for General permit & Regional Permit) to meeting 8/12/09.
- (Judy) Meeting 8/12/09 to discuss extraction methods (any defined should be off table?), monitoring conditions (add any? Suggested conditions?), other types of adaptive management (what's involved, etc?).
- Defining parameters for permitting extraction framework removal.
- (Lori) Will discuss annual discharge measurement, flow, input, and how much recovery will be needed with Tech team and get ideas.
- (Kevin) educated best professional judgment required to set structure for workshop working from Tech team questions and issues.
- Important: effects of mining on Habitat of Fish & Wildlife, in-water work period. Can we avoid? If not, need directions how to seek to avoid or seek to mitigate.

<u>Represented at South Slough workshop in September:</u>
COE: Judy Linton & Erik Petersen
DSL: Kevin Moynahan, Lori Warner-Dickason, Bob Lobdell
OCAPA: Rich Angstrom and others
Umpqua Sand: Joy Smith
Freeman Rock: Ted Freeman; Bill Yocum
ODFW: Patty Snow, Todd Confer, 2 others
DEQ: Sally Puent, Alex, (others from region)
NOAA: Kim Kratz, Chuck Wheeler
USFW: to be determined (Janine Castro won't be there)
DLCD: Jay Charland

ACTION: Janine will contact Brian Clure with NOAA - he will be a good addition to the meeting); Dennis Halligan will also be contacted.

2. **<u>Next Steps:</u>**

Discuss later: NOAA to consider factors if cease operations, not only impacts due to extraction

- Next meeting September 24th & 25th at South Slough. (Not open to the public).
- Objective: Identify challenges, questions, etc. and come together to find answers. Prioritize important issues down the road and impact. Bring info and critique 1) substance, 2) right people are present, 3) drive to results. **Gail Achterman will be chair**

From:	Achterman, Gail
To:	MOYNAHAN Kevin; Petersen, Erik S NWP; CHARLAND Jay; GERMOND Jon P; kim.kratz@noaa.gov; BETTS Lesley; monty_knudsen@fws.gov; DECONCINI Nina
Cc:	LIVERMAN Alex; LOBDELL Bob; Linton, Judy L NWP; WARNER-DICKASON Lori; nancy.johnson@noaa.gov; PUENT Sally; suel.lurie@oregonstate.edu
Subject:	RE: Agency meeting prior to Sept workshop
Date:	Wednesday, August 19, 2009 5:44:06 PM

All-
I think it is always useful to have frank discussions with participants in workshops like this. When DEQ suggested an agency only meeting, I talked to Nina about the importance of only doing so if we had a similar meeting with industry.
Megan K and Sue Lurie will call Rich Angstrom to arrange the industry meeting.
At both sessions, I want to gain an understanding of expectations for the workshop and any concerns that participants have.
Gail

From: MOYNAHAN Kevin [mailto:kevin.moynahan@state.or.us]
Sent: Wed 8/19/2009 2:19 PM
To: erik.s.petersen@usace.army.mil; Achterman, Gail; CHARLAND Jay; GERMOND Jon P; MOYNAHAN Kevin; kim.kratz@noaa.gov; BETTS Lesley; monty_knudsen@fws.gov; DECONCINI Nina
Cc: LIVERMAN Alex; LOBDELL Bob; Linton, Judy L NWP; WARNER-DICKASON Lori; nancy.johnson@noaa.gov; PUENT Sally
Subject: RE: Agency meeting prior to Sept workshop

Nina - thank you - perhaps it was miscommunication - I didn't see reference to the separate meeting between Gail and industry in the e-mail from Lesley. With this clarification, DSL will be pleased to participate in this agency discussion.

Kevin

From: DECONCINI Nina [mailto:nina.deconcini@state.or.us]
Sent: Wednesday, August 19, 2009 2:16 PM
To: erik.s.petersen@usace.army.mil; gail.achterman@oregonstate.edu; CHARLAND Jay; GERMOND Jon P; MOYNAHAN Kevin; kim.kratz@noaa.gov; BETTS Lesley; monty_knudsen@fws.gov
Cc: LIVERMAN Alex; LOBDELL Bob; WARNER-DICKASON Lori; nancy.johnson@noaa.gov; PUENT Sally
Subject: Re: Agency meeting prior to Sept workshop

Thanks for the reply Kevin.

I spoke to Gail by phone yesterday and she endorsed the idea of meeting with the state\federal agencies separately, and having another industry only meeting with her and her partners, as a way to understand each group's perspective prior to the facilitated workshop in Sept.

I recognize and value the contribution of OCAPA's and individual representatives participating with us as partners, and view the separate gatherings as complimentary to achieving a collectively desired outcome.

We should continue to discuss issues with industry and allow for state\federal agency only discussions when warranted.

I think we will be able to accomplish both meetings in time for the Sept workshop.

Nina

Sent from my BlackBerry Wireless Handheld

From: MOYNAHAN Kevin
To: erik.s.petersen@usace.army.mil ; gail.achterman@oregonstate.edu ; CHARLAND Jay; GERMOND Jon P; kim.kratz@noaa.gov ; BETTS Lesley ; monty_knudsen@fws.gov ; DECONCINI Nina
Cc: LIVERMAN Alex ; LOBDELL Bob; WARNER-DICKASON Lori; nancy.johnson@noaa.gov ; DECONCINI Nina ; PUENT Sally
Sent: Wed Aug 19 09:25:39 2009
Subject: RE: Agency meeting prior to Sept workshop

Nina/Lesley

There has already been quite a bit of work (and continuing even today) done by respective members of the Exec and Tech Teams in framing the issues for the workshop. Further, OCAPA (and certain members) are partners in the Exec and Tech Team process and are contributing time and $$ to the workshop. They have a vested interest in participating in discussions related to framing up the issues for the workshop. I believe they should continue to have the ability to participate in discussions on this issue and that it should not be an agency only discussion.

Kevin

From: BETTS Lesley [mailto:lesley.betts@state.or.us]
Sent: Tuesday, August 18, 2009 2:06 PM
To: erik.s.petersen@usace.army.mil; gail.achterman@oregonstate.edu; CHARLAND Jay; GERMOND Jon P; MOYNAHAN Kevin; kim.kratz@noaa.gov; monty_knudsen@fws.gov
Cc: LIVERMAN Alex; nancy.johnson@noaa.gov; DECONCINI Nina; PUENT Sally
Subject: Agency meeting prior to Sept workshop

All,

On behalf of Nina DeConcini, I am sending this email to set up a meeting or a conference call for just the state and federal agencies involved in the Chetco Gravel RGP process prior to the Sept. 24th and 25th facilitated workshop. This will allow us to clarify expectations and frame the discussion for the workshop, so that we come away from it with valuable information that will inform our permitting decisions. The Technical Team is preparing a list of questions on the issues to be considered from the USGS report for potential discussion by the Tech and Exec Teams and the expert panel at the workshop. This document can be used as a basis for our meeting discussion.

DEQ can host the meeting and we can arrange for a call in number/access code for those not able to attend in person.

Gail, I know Nina attempted to reach you by phone prior to leaving on vacation. We would like to have you participate in the meeting, in person or by phone, schedule permitting. If there is someone I can work with to arrange this, please let me know.

Thanks again.

Lesley Betts

Executive Assistant

DEQ NW Region

betts.lesley@deq.state.or.us

503-229-5372

My Hours: Monday-Thursday 7:30-4:30, Friday 7:30-2:00

From:	Bill Yocum
To:	kevin.moynahan@state.or.us; Petersen, Erik S NWP
Cc:	tedf@hughes.net; jabar40@dishmail.net; joy@umpquasand.com; rich@ocapa.net; Linton, Judy L NWP; Lori.Warner-Dickason@state.or.us; robert.lobdell@dsl.state.or.us; Puent.Sally@deq.state.or.us; deconcini.nina@deq.state.or.us; Kim.Kratz@noaa.gov; karmen.fore@mail.house.gov; Molly_McCarthy@wyden.senate.gov; jessica_Adamson@merkley.senate.gov; rep.waynekrieger@state.or.us; prattd@co.curry.or.us; frittsj@co.curry.or.us; darreln@hughes.net; gvedwards@hughes.net
Subject:	Aggregate Workshop Questions
Date:	Friday, August 21, 2009 9:47:08 AM

Hello Kevin and Erik,

Freeman Rock was disappointed in the questions that the Inter-Agency Tech Team developed for the upcoming Workshop. Freeman Rock gave considerable thought about their questions and concluded that the Tech Team has made a decision that the Chetco habitat and water quality is in a degraded condition because of aggregate removal. Freeman Rock does not agree with this conclusion and finds no rational in the USGS Study to support the Tech Team findings. Freeman Rock has developed the following five questions and believes that these questions are objective and not pre-decisional on the condition of the Chetco River. Please review these questions and let us know if we are heading in the correct direction. We all want the upcoming Workshop to be productive we must focus on ways to improve management of our resources to balance the needs of our environment with the needs of our society.

Ted Freeman Jr. & Bill Yocum
Freeman Rock Inc.

541-469-2444

??Questions??

Aggregate Workshop Sept. 24-25, 2009

1. What are the issues/concerns for habitat and water quality for the Lower Chetco River (RM 0 – RM 11) and the identified USGS reaches (Upper Reach, Emily Ck. Reach, Mill Ck. Reach, No. Fk. Reach, Estuary Reach)? More specifically, what habitat are we aiming to protect and for what reason?

2. What geomorphological features compliment habitat and water quality for the different reaches in the Lower Chetco River?

3. What are the monitoring goals/objectives for the Lower Chetco River and the identified USGS reaches? Is there an objective target we can all shoot for?

4. What are the short-term and long-term monitoring needs for each reach with and without gravel removal operations? And how are they to be done?

5. With so many agencies involved, each with their own and often conflicting spheres of interest, how do we bring this to a conclusion in forming the RGP/GP? Who will be the final arbiter?

From:	Petersen, Erik S NWP
To:	WARNER-DICKASON Lori; LIVERMAN Alex; MOYNAHAN Kevin; Rich Angstrom (rich@ocapa.net); CHARLAND Jay; Joy Smith; vallette.yvonne@epa.gov; Linton, Judy L NWP; PUENT Sally; DECONCINI Nina; "Kim Kratz"; Monty_Knudsen@fws.gov; Yvonne Vallette (vallette.yvonne@epa.gov); "Michael Szerlog"
Cc:	LIVERMAN Alex; Chuck Wheeler; "Sue Lurie"; "Megan Kleibacker"; Ellis, Karla G NWP; Giannico, Guillermo - FW; "Achterman, Gail"
Subject:	24 SEP EXEC MEETING IN PORTLAND, POSTPONED WORKSHOP & DISCUSSION QUESTIONS
Date:	Thursday, September 10, 2009 2:05:17 PM
Attachments:	Chetco Gravel Mining Workshop questions.al edits.doc

Team - after discussion with Gail, Rich and Kevin today, it became apparent that the panel member availability for our South Slough workshop on 24-25 Sep was still sketchy and our agenda was not adequately solidified. In recognition that a short delay would allow us to better prepare for the workshop and would not impact scheduled milestones at this point, we elected to slip the scheduled workshop for 30-45 days. Megan (from OSU) will be sending out a Doodle message to scope participant availability and Gail, Guillermo and folks will continue to work panel availability issues.

In that light, we will be hosting an Executive team meeting at noon on 24 Sep in Portland at the Corps office (room TBD) with the goal of updating where the tech team is at and discussing potential permit parameters.

Also - please find attached what I believe are the latest edits of concerns & questions raised by the Technical Committee for consideration dialogue at the future workshop.

Thanks for your commitment, patience and support in advance - esp

Chetco Gravel Mining Workshop
September 24-25, 2009

Discussion Questions for the Group

Introduction and purpose: The purpose of this workshop is to gather input from experts to assist the agencies in making a sound decision on future gravel removal on the Chetco River. The agencies have before them applications for a GP (DSL) and RGP (Corps) and are considering whether commercial gravel removal may continue in the Chetco system.

DSL, the Corps and other agencies are reviewing and assessing information to make informed decisions on the GP/RGP applications. The agencies have been working collaboratively with the gravel industry (OCAPA and individual operators) in this effort. The intent of the process is to determine if gravel removal from the system is permittable based on recruitment of material into and through the system and any impacts to habitat, water quality, or other resources from material extraction. If gravel extraction is permittable, the agencies will be determining appropriate permit conditions, monitoring requirements, and adaptive management approaches to govern removal activities.

The regulatory agencies will not be making final permit decisions at this workshop. The workshop is an opportunity to discuss and investigate scientific, policy and other supported concepts to better inform permit decisions.

The agencies are using a number of sources for permit review and determinations. The US Geological Survey Open File Report 2009-1163 will be used as the best available science to evaluate current conditions on the Chetco. Other sources of information will be used as relevant to this process. Although the USGS report focuses on the physical conditions of the river, the agencies will be using this information as indirect indicators of the biological characteristics.

The following questions were developed by the Tech Team from review of the USGS report.

1. What does the USGS report tell us about the current condition of the Chetco?

2. ~~What~~ The Tech Team interprets the USGS report findings ~~should~~ to be used to evaluate if gravel extraction is appropriate on the ~~Chetco~~Chetco to be derived from the following indicators: ~~?~~ ~~What other indicators need to be considered in this process? Possible indicators include:~~

   a. The degree of incision
   b. The degree of bar armoring

c. The degree of coarsening of bed material
d. The degree of sinuosity of the channel (especially at the Mill Creek/North Fork reach)
e. The rate or frequency of channel migration
f. Size and location of the gravel bars

What other indicators need to be considered in this process?

3. Relative to the USGS report findings on material recruitment into the system and proposed gravel extraction out, -as well as other removal activities on the Chetco –
   a. does Does the system require a "recovery period" to restore a balance to the system?
   b. If so, can gravel extraction and other removal activities continue during this period?
   3.c. If so, at what level and under what conditions?

4. The USGS study indicates that the Chetco is flow limited (as opposed to supply limited) with respect to gravel recruitment, which ranges from 103,000 cubic yards at very low flow years to over 150,000 cubic yards in high flow years. Can this model
   a. Is there a method that can be used to reliably estimate annual recruitment and develop a process allowing extraction of some percentage of that volume?
   4.b. What percentage would be appropriate?

5. The agencies are considering employing adaptive management to determine whether gravel should be minedcan be extracted and how much extraction should be allowed in any given year. Adaptive management would involve evaluating physical and or biological indicators to confirm that the river is moving toward recovery.

   a. Which Potential indicators include:
   - Recurrence of transporting flows (via stream gauges and rainfall)
   - The degree of incision
   - The degree of bar armoring
   - The degree of coarsening of bed material
   - The degree of sinuosity of the channel (especially at the Mill Creek/North Fork reach)
   - The rate or frequency of channel migration
   - Size and location of the gravel bars
   - Loss or gain of pool/riffle complexes
   - Loss or gain of overhanging vegetation
   - Presence/absence of target species
   - Improvement or degradation of local water quality (eg, temp, sedimentation, turbidity, DO, pH)

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~~a.~~ Are there other physical or biological indicators would assist the agencies in confirming, on an annual basis, that the river is moving toward recovery?

b. The technical team developed several proposed conditions related to data acquisition and monitoring (see attached). Please comment on the effectiveness of these conditions in evaluating the physical and/or biological indicators identified in question 5a.

6. Which physical or biological indicators would assist the agencies in confirming, on an annual basis, that the river is moving toward recovery?

7. Are there any active management techniques (e.g., mechanical movement of existing sediment at specific locations) that could be employed to enhance or accelerate recovery?

8. What extraction techniques and conditions could be employed that would conserve habitat/water quality and support the health of the system?

9. ~~What is the effect on the system if~~Without gravel and other removal activities ~~are not permitted~~, the USGS report indicates the potential for aggardation, esp. at the wide, flat reaches near Mill creek/No. Fork.~~?~~ ~~How would this benefit or impact~~ Larger bars, dynamic channels, and increased sinuosity may arise from this likely aggradation to benefit habitat, water quality, ~~flooding,~~ recreational fishing, ~~navigability~~ and, local availability of gravel material for road and other projects. However, negative impacts to flooding, and navigation~~, impact on the local economy~~. must also be considered. How can adaptive management address both benefits and impacts?

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Comment [DB1]: Redundant to 5a

Comment [DB2]: This is too broad and without basis. The report describes buildup of gravel at the wide, flat Mill Creek/No Fork reach, which could lead to channel migration, increased sinuosity, and flooding. There are both benefits and impacts to all the uses listed here. Are we asking them to weigh or rank the impacts vs benefits? Economic impacts are incurred with both benefits and impacts, and is not within our charge as a primary consideration, so this should be removed from the question or indicated that it balances in either scenario.

From:	Petersen, Erik S NWP
To:	LOWE Lesley; MOYNAHAN Kevin; GERMOND Jon P; kim.kratz@noaa.gov; monty_knudsen@fws.gov; CHARLAND Jay; gail.achterman@oregonstate.edu; PUENT Sally; DECONCINI Nina; LIVERMAN Alex; Lurie, Sue; Kleibacker, Megan; Ellis, Karla G NWP; Rich Angstrom (rich@ocapa.net); tedf@hughes.net; Linton, Judy L NWP; WARNER-DICKASON Lori
Cc:	nancy.johnson@noaa.gov; Bain, Julie
Subject:	JOINT TECH/EXEC MEETING 24 SEP 09, 1200 - Portland, RDP
Date:	Friday, September 11, 2009 5:23:49 PM
Attachments:	Exec_Tech Team Roles signed.pdf Chetco Gravel Mining Workshop questions.al edits.doc
Importance:	High

Guys - thanks for an interesting interagency call today. I appreciated the dialogue as well as the focus brought to bear on the subject of our gravel initiative workshop content.

If we go back to the inception of the initiative, our intent was to drive timeliness and certainty on decisions related to gravel extraction on watersheds - the Corps of Engineers has now expended nearly $1M to support studies answering questions that will help all of us do this. Most of you have expended significant staff resources in support of this effort as well. I know we are all committed to driving a better, more defensible and efficient processes for all.

When we realized this spring that the late release of the USGS studies precluded Section 7 consultation in time to develop permits for this season's in-water work window, our contingency approach was to use additional time we had to do a better job - to understand the facts, identify issues and begin to work jointly on conditions to address (avoid, minimize or mitigate) the issues. The chairs of the executive team, in concert with our industry representative partner, agreed on this intent. We subsequently committed to engage experts - geofluvialmorphologists and fisheries scientists, to help us understand facts correctly, frame questions and begin to address conditions smartly - with the hopes our agencies could take this information back as feedback and if possible begin to develop permits that would be intelligent and have general buy-in from our partners.

We recognize necessarily the role of agency independence and authority in developing permits and permit conditions. Our goal for the Workshop is NOT to use the workshop to draft Regional General Permits or General Permits. Frankly, we recognize that no decision has been made on the Chetco regarding whether or not extraction will be permitted. But we saw an opportunity here to build understanding and perhaps foster consensus as to if (and subsequently some elements of how and where and when) gravel extraction might be possible. We still need to move forward in this direction.

We decided on the phone today to host a joint exec/tech team in Portland at the Corps office at Noon on 24 September - room TBD. Our planned agenda will be to 1) foster dialogue and clarification on the list of questions/concerns raised by the tech team from the USGS study with tech team members as well as OSU workshop supporters; 2) allow the tech and exec teams to split apart and have the tech team a) meet with Gail Achterman to clarify/reframe questions and b) gain exec team consensus on the workshop agenda, approach and outcome. I believe this was the outcome of our conversation today - speak up please if I missed it.

I'd also like to see the exec team accomplish two more goals - to 3) discuss the types of experts we're bringing in for the workshop and specifically how we'll use them in the agenda and 4) address whether the USGS studies have adequately addressed concerns raised by NMFS and USFWS at the onset of this process.

Megan zipped a Doodle poll out to the exec and tech team members for rescheduling the workshop - please use it for your availability.

After Gail meets with industry in prep for the workshop, I would prefer not to have more agency-only or industry-only meetings within the framework of partnership issues. I understand we had to do this earlier this summer in support of accessing pre-final USGS data, but believe we diminish transparency and the spirit of partnership every time we convene this way.

I apologize for the length of this message. Thanks for those of you who took time to read it. Attached, find the tech team's questions as well as a copy of our original charter.

Best regards - esp

-----Original Message-----
From: LOWE Lesley [mailto:LOWE.Lesley@deq.state.or.us]
Sent: Thursday, September 10, 2009 4:36 PM
To: MOYNAHAN Kevin; Petersen, Erik S NWP; GERMOND Jon P; kim.kratz@noaa.gov; monty_knudsen@fws.gov; CHARLAND Jay; gail.achterman@oregonstate.edu; PUENT Sally; DECONCINI Nina; LIVERMAN Alex; Lurie, Sue; Kleibacker, Megan
Cc: nancy.johnson@noaa.gov; Bain, Julie
Subject: Agency gravel meeting agenda

All,

It appears the late September workshop will be postponed. However, tomorrow's agency meeting is still on for 2:30 to 4:00 pm, here at DEQ NW Region.

For those coming in person, we're located at 2020 SW 4th Avenue, 4th floor, Portland, OR 97201 in conference room E.

For those connecting by phone, the call in number is: 1-503-378-3313 (this is a Salem number so dial 1 appropriately)

Here is a proposed agenda, and we can consider other topics based on the group's interest.

AGENDA:

· Discussion of Agencies' views on the purpose and goals of the workshop

--discuss findings from the USGS report and how they will influence permitting decisions

· Agreement on the outcome of the workshop we want to achieve (understanding that we will be having an Exec team meeting at the end of the month to help shape the discussion).

--Workshop expert panel input on issues identified by the Tech Team from the USGS report

--An open, facilitated discussion between industry and agencies on issues identified in the report

-Develop a common understanding among all participants about the steps needed and schedule required to develop an RGP/GP for the Chetco River which could serve as a template for permits on other river systems

Thanks and sorry for the last minute email.

Lesley Lowe

Executive Assistant

DEQ NW Region

lowe.lesley@deq.state.or.us

503-229-5372

My Hours: Monday-Thursday 7:30-4:30, Friday 7:30-2:00

10 July 2008

Regional Gravel Initiative

Gravel Executive Team/Technical Team Roles and Responsibilities, and Scope of Project Outline Related to a Watershed Evaluation of In-Stream Gravel Operations

Two interagency teams (the Gravel Executive Team and Gravel Technical Team) have been established in an effort to strategically evaluate, on a watershed basis, whether the mining of gravel from Oregon rivers can be supported. As permitting agencies charged under state and federal law with review and decision making related to applications for in-stream gravel mining operations in the State of Oregon, the U.S. Army Corps of Engineers, Portland District (Corps) and the Oregon Department of State Lands (DSL) act as co-chairs of both the Executive and Technical Teams (Teams).

In addition to the Corps and DSL, the Teams consist of representatives from the following: Oregon Department of Fish and Wildlife (ODFW); Oregon Department of Environmental Quality (ODEQ); Oregon Department of Land Conservation and Development (ODLCD); U.S. Fish and Wildlife Service (USFWS); National Marine Fisheries Service (NMFS); U.S. Environmental Protection Agency (EPA); Oregon Concrete and Aggregate Producers Association (OCAPA); participating county planning departments; and current/prospective commercial mining operators based on the watershed being evaluated. Both the Executive and Technical Teams will be made up of one representative of the agencies/organizations listed above. The gravel industry will be represented on the Technical Team by a general technical representative/consultant. There can also be one OCAPA representative or operator from the watershed to attend Technical Team meetings as an "observer". That person will be present to listen only. They can provide information on gravel operations only at the request of the Technical Team. The Technical Team may also seek other appropriate expertise depending upon the issue being discussed by them.

The overall goal of this regional gravel initiative is for the Corps and DSL to consider developing regional general permits (RGP) and general permits (GP), respectively, for commercial gravel mining activities in various watersheds throughout Oregon. It is the role of the Executive Team to ensure progress continues, and to provide support and direction to the Technical Team.

It is the role of the Technical Team to scope, collect, review and analyze data and other information to present recommendations in a coordinated fashion to the Executive Team for the particular watershed being evaluated. Technical Team discussions will be restricted to technical issues and may include invitations to individuals with specific technical expertise on an as needed basis.

While this regional gravel initiative moves forward, it is understood the Corps and DSL must continue to process individual applications for gravel mining throughout the state. Although certain Technical Team representatives may also be responsible for evaluating these individual applications as part of their agency duties, the RGP specific Technical Team meeting times will not be used to discuss these projects.

In working through the regional gravel initiative, it is understood the criteria for permit and related decision making processes come from federal, state and local statutes, regulations, and codes. For example, there may be federal Endangered Species Act (ESA) and Magnuson-Stevens Act Essential Fish Habitat (EFH) consultations required as part of the permitting process. All appropriate laws, regulations, and codes will be followed.

River Specific Evaluations:

The Chetco River was chosen as the first study river for the regional gravel initiative. Phase 1 study efforts focused on evaluating existing information to determine vertical stability (i.e. whether the system was aggrading, degrading, or in equilibrium). Phase 2 study efforts will evaluate sediment transport and biological data requirements. A scope of work (SOW) for investigation of the Chetco River system has been completed by USGS and is expected to be implemented during the summer/fall of 2008 with a preliminary report available in January 2009 and a final report anticipated in April 2009.

I. Chetco River Operations

A. The Corps and DSL issued permits to Freeman Rock and Tidewater Contractors authorizing gravel extraction through the 2008 in-water work period on the portion of the Chetco from head of tide to just past the second bridge at approximately river mile 11. In support of these permitting decisions, NMFS issued a biological opinion, ODEQ issued Water Quality Certification, and ODLCD concurred the projects were consistent with the Oregon Coastal Management Program.

B. The Corps and DSL will work to develop a RGP and GP respectively, as the vehicle for authorizing continued mining on the Chetco River beyond 2008. The goal is to make a final decision on the respective permits by June 30, 2009. The Technical Team will provide scientific and technical input to the Executive Team and the Corps/DSL to develop the anticipated RGP/GP and inform the agency decision-making on these permits.

C. The agencies will continue to gather relevant information during development of the RGP/GP for the Chetco operations. In the event issues cannot be adequately addressed and more studies are needed to complete the RGP/GP process, the Corps and DSL may exercise the options listed below.

   1. Permit applications may be placed on hold or denied pending data collection and information gathering,
   2. Individual short-term permits may be granted, but with limited gravel volumes or other conditions to minimize impacts. This option includes all relevant permitting requirements being met, including re-initiation of ESA consultation with NMFS and evaluation for 401 Water Quality Certification by DEQ.

D. It is understood that evaluation of the Phase 1 and Phase 2 studies and all other relevant information will be used to determine final permitting decisions for gravel mining in the Chetco River system. The Technical Team will develop a document for presentation to the Executive Team summarizing their analyses and any recommendations regarding project permitting. The Corps and DSL will use this document as part of their respective agency decision making related to consideration of any future request for commercial gravel mining in the Chetco River.

E. Lower Tidewater project: The Tidewater location below head of tide will be included in the development of the RGP/GP for commercial gravel mining activities in the Chetco system. The Technical Team will continue to work with USGS in identifying and synthesizing any data gaps required to be addressed below head of tide on the Chetco to inform RGP/GP permitting decisions.

II. Operations on other river systems

A. The Phase 1/Phase 2 study process used on the Chetco River will serve as a model for evaluating other river systems. The Technical Team, in coordination with the gravel industry, will recommend the priority of future river systems to be studied. Presently, the Umpqua, Rogue, Tillamook, and Coquille systems have been identified as the next systems to be studied in the order listed.
B. The Technical Team will develop a list of information needs and recommend a process for obtaining and evaluating the information. This may involve an evaluation of existing data and a recommendation for additional data collection to fill information gaps.
C. The Executive Team will approve or revise recommendations made by the Technical Team, and will develop strategies to distribute informational materials to potential operators and to fund necessary studies and data collection in support of the development of the watershed specific RGP/GP.

This process is agreed to by the following members of the Executive Team:

U.S. Army Corps of Engineers

OR Department of State Lands

National Marine Fisheries Service

OR Department of Environmental Quality

U.S. Fish and Wildlife Service

OR Department of Fish and Wildlife

Environmental Protection Agency

OR Dept of Land Conservation & Develop

OCAPA

Chetco Gravel Mining Workshop
September 24-25, 2009

Discussion Questions for the Group

Introduction and purpose: The purpose of this workshop is to gather input from experts to assist the agencies in making a sound decision on future gravel removal on the Chetco River. The agencies have before them applications for a GP (DSL) and RGP (Corps) and are considering whether commercial gravel removal may continue in the Chetco system.

DSL, the Corps and other agencies are reviewing and assessing information to make informed decisions on the GP/RGP applications. The agencies have been working collaboratively with the gravel industry (OCAPA and individual operators) in this effort. The intent of the process is to determine if gravel removal from the system is permittable based on recruitment of material into and through the system and any impacts to habitat, water quality, or other resources from material extraction. If gravel extraction is permittable, the agencies will be determining appropriate permit conditions, monitoring requirements, and adaptive management approaches to govern removal activities.

The regulatory agencies will not be making final permit decisions at this workshop. The workshop is an opportunity to discuss and investigate scientific, policy and other supported concepts to better inform permit decisions.

The agencies are using a number of sources for permit review and determinations. The US Geological Survey Open File Report 2009-1163 will be used as the best available science to evaluate current conditions on the Chetco. Other sources of information will be used as relevant to this process. Although the USGS report focuses on the physical conditions of the river, the agencies will be using this information as indirect indicators of the biological characteristics.

The following questions were developed by the Tech Team from review of the USGS report.

1. What does the USGS report tell us about the current condition of the Chetco?

2. ~~What~~ The Tech Team interprets the USGS report findings ~~should~~ to be used to evaluate if gravel extraction is appropriate on the ~~Chetco~~Chetco to be derived from the following indicators: ~~?~~ ~~What other indicators need to be considered in this process? Possible indicators include:~~

    a. The degree of incision
    b. The degree of bar armoring

c. The degree of coarsening of bed material
d. The degree of sinuosity of the channel (especially at the Mill Creek/North Fork reach)
e. The rate or frequency of channel migration
f. Size and location of the gravel bars

What other indicators need to be considered in this process?

3. Relative to the USGS report findings on material recruitment into the system and proposed gravel extraction out, -as well as other removal activities on the Chetco –
   a. does Does the system require a "recovery period" to restore a balance to the system?
   b. If so, can gravel extraction and other removal activities continue during this period?
   3.c. If so, at what level and under what conditions?

4. The USGS study indicates that the Chetco is flow limited (as opposed to supply limited) with respect to gravel recruitment, which ranges from 103,000 cubic yards at very low flow years to over 150,000 cubic yards in high flow years. Can this model
   a. Is there a method that can be used to reliably estimate annual recruitment and develop a process allowing extraction of some percentage of that volume?
   4.b. What percentage would be appropriate?

5. The agencies are considering employing adaptive management to determine whether gravel should be minedcan be extracted and how much extraction should be allowed in any given year. Adaptive management would involve evaluating physical and or biological indicators to confirm that the river is moving toward recovery.

   a. Which Potential indicators include:
   - Recurrence of transporting flows (via stream gauges and rainfall)
   - The degree of incision
   - The degree of bar armoring
   - The degree of coarsening of bed material
   - The degree of sinuosity of the channel (especially at the Mill Creek/North Fork reach)
   - The rate or frequency of channel migration
   - Size and location of the gravel bars
   - Loss or gain of pool/riffle complexes
   - Loss or gain of overhanging vegetation
   - Presence/absence of target species
   - Improvement or degradation of local water quality (eg, temp, sedimentation, turbidity, DO, pH)

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~~a.~~ Are there other physical or biological indicators would assist the agencies in confirming, on an annual basis, that the river is moving toward recovery?

b. The technical team developed several proposed conditions related to data acquisition and monitoring (see attached). Please comment on the effectiveness of these conditions in evaluating the physical and/or biological indicators identified in question 5a.

6. Which physical or biological indicators would assist the agencies in confirming, on an annual basis, that the river is moving toward recovery?

7. Are there any active management techniques (e.g., mechanical movement of existing sediment at specific locations) that could be employed to enhance or accelerate recovery?

8. What extraction techniques and conditions could be employed that would conserve habitat/water quality and support the health of the system?

9. ~~What is the effect on the system if~~Without gravel and other removal activities ~~are not permitted~~, the USGS report indicates the potential for aggardation, esp. at the wide, flat reaches near Mill creek/No. Fork.~~?~~ ~~How would this benefit or impact~~ Larger bars, dynamic channels, and increased sinuosity may arise from this likely aggradation to benefit habitat, water quality, ~~flooding,~~ recreational fishing, ~~navigability~~ and, local availability of gravel material for road and other projects. However, negative impacts to flooding, and navigation~~, impact on the local economy~~. must also be considered. How can adaptive management address both benefits and impacts?

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Comment [DB1]: Redundant to 5a

Comment [DB2]: This is too broad and without basis. The report describes buildup of gravel at the wide, flat Mill Creek/No Fork reach, which could lead to channel migration, increased sinuosity, and flooding. There are both benefits and impacts to all the uses listed here. Are we asking them to weigh or rank the impacts vs benefits? Economic impacts are incurred with both benefits and impacts, and is not within our charge as a primary consideration, so this should be removed from the question or indicated that it balances in either scenario.

From: Rich Angstrom
To: Linton, Judy L NWP
Subject: RE: workshop questions
Date: Tuesday, September 29, 2009 11:51:55 AM

Please - I need a hydrologist helping. I plan to deal with the fish issues and Chris the hydrology issues. It will also help him follow the discussions in preparation for the workshop. Working on collecting the scientific studies.

Richard Angstrom
President
Oregon Concrete & Aggregate Producers Association
737 13th St. SE, Salem, OR 97301
Phone: 503-588-2430 ext.8
Fax: 503-588-2577

-----Original Message-----
From: Linton, Judy L NWP [mailto:Judy.L.Linton@usace.army.mil]
Sent: Tuesday, September 29, 2009 11:47 AM
To: Rich Angstrom
Subject: RE: workshop questions

Yes, I'll have a call in number. Probably will not send it out until mid part of next week.

Re: further contact with Chris Lidstone - should I continue to inform him of meeting dates, etc or not given that you are now on the tech team? Thanks.

-----Original Message-----
From: Rich Angstrom [mailto:rich@ocapa.net]
Sent: Tuesday, September 29, 2009 11:40 AM
To: Linton, Judy L NWP
Subject: RE: workshop questions

Thanks Judy,

Will there be a call in number for the tech meeting? I will be in La Grand calling in. I will try to be physically present at the other meetings.
Thank you.

Richard Angstrom
President
Oregon Concrete & Aggregate Producers Association
737 13th St. SE, Salem, OR 97301
Phone: 503-588-2430 ext.8
Fax: 503-588-2577

-----Original Message-----
From: Linton, Judy L NWP [mailto:Judy.L.Linton@usace.army.mil]
Sent: Tuesday, September 29, 2009 8:40 AM
To: Rich Angstrom
Subject: workshop questions

Rich: workshop questions plus the proposed monitoring requirements developed by the tech team. The second attachment is referenced in workshop question 5b. Judy

-----Original Message-----
From: Linton, Judy L NWP
Sent: Wednesday, September 23, 2009 11:28 AM
To: 'Bob Bailey'; 'David Pratt'; 'Jon Germond'; 'Joy Smith'; 'Ken Phippen'; 'Kevin Moynahan'; 'Kim Kratz'; 'Michael Szerlog'; 'Monty Knudsen'; 'Rich Angstrom'; 'Sally Puent'; 'Ted Freeman'; 'Alex Liverman'; 'Bill Yocum'; 'Bob Lobdell'; 'Chris Lidstone'; 'Chuck Wheeler'; 'Janine Castro'; 'Jay Charland'; 'Jodi Fritts'; Linton, Judy L NWP; 'Lori Warner-Dickason'; 'Patty Snow'; 'Robert Elayer'; 'Yvonne Vallette'
Subject: Joint Exec/Tech Team meeting (9/24)

Good morning to all -

A reminder of the joint Executive and Technical Team meeting scheduled for Thursday September 24 starting at 1:00p. The meeting will be held at the Corps offices in Portland in our HDC Conference Room (left off the elevators then right at the next hallway). A conference line has been set-up for those needing to participate by phone - <<Chetco Gravel Mining Workshop questions and edits #3.doc>> (888) <<Chetco River Gravel_prelim monitoring req_final.doc>> 285-4585; participant code 585150

One focus of the meeting will be the questions being prepared for the Chetco Gravel workshop - attached is a slightly revised version from the last document Erik provided to you all. Concepts are mostly the same but wording in some of the questions may have changed. Also, question 5 references Tech Team proposed conditions relative to data acquisition and monitoring; a copy of those conditions are attached as well.

If you have not done so already, please confirm your physical attendance so I can get your name in the visitor system. REMINDER: if you haven't been here in awhile, non-federal folks will be subject to a search (including bags) so please allow extra time.

Let me know if questions - Judy (503-808-4382)

From:	MOYNAHAN Kevin
To:	Alex Liverman; BAILEY Bob; brian.cluer@noaa.gov; byocum@hughes.net; cdl@lidstone.com; Chuck Wheeler; Dennis Halligan; Petersen, Erik S NWP; janine_m_castro@fws.gov; CHARLAND Jay; joe_zisa@fsw.gov; BRAGG John; GERMOND Jon P; joy@umpquasand.com; Linton, Judy L NWP; ken.phippen@noaa.gov; kim.kratz@noaa.gov; lori.warner-dickason@state.or.us; Kleibacker, Megan; monty_knudsen@fws.gov; James E O"connor; SNOW Patty; Klingeman, Peter C.; David Pratt; relayer@twcontractors.com; Rich Angstrom; sally.puent@state.or.us; Gregory, Stanley V - FW; szerlog.michael@epamail.epa.gov; tedf@hughes.net; CONFER Todd A; Tullos, Desiree D - ONID; vallette.yvonne@epa.gov
Cc:	Giannico, Guillermo - FW; Achterman, Gail; Lurie, Sue
Subject:	RE: Gravel Workshop
Date:	Monday, October 12, 2009 4:46:28 PM

Hi all - confirming the gravel workshop will be held at the South Slough National Estuarine Reserve in Charleston on November 30th and December 1st. There will be more details related to agenda and workshop schedule etc. coming out soon. I just wanted to confirm the location of the workshop at this point.

Thanks, Kevin

From:	Linton, Judy L NWP
To:	"Alex Liverman"; "Bob Lobdell"; "Chris Lidstone"; "Chuck Wheeler"; "Janine Castro"; "Jay Charland"; "Jim O"Connor"; "Jodi Fritts"; Linton, Judy L NWP; "Lori Warner-Dickason"; "Patty Snow"; "Rich Angstrom"; "Rose Wallick"; "Todd Confer"; "Yvonne Vallette"; "byocum@hughes.net"; "Robert Elayer"
Cc:	Petersen, Erik S NWP; "MOYNAHAN Kevin"; Ellis, Karla G NWP
Subject:	Chetco Schedule - Revised
Date:	Thursday, October 22, 2009 10:23:43 AM
Attachments:	Chetco RGP scheduleOct09.xls

Here is the revised schedule for the Chetco permit process based on discussions from our Oct 9 Tech Team meeting - let me know if comments.

I show the Corps/DSL public review process as occurring in February 2010. One thing we need to discuss further is appropriate time for the public meeting, which is not required for the Corps process but is something DEQ has promised to hold as part of their review. While DEQ would be the host, I think it would be beneficial for the stakeholder community to have as many of the agencies present as possible. It would be an opportunity for us all to explain what is left in our process, explain the decisions we have made to that point, etc. My thought on timing is no later than April... Judy

** DRAFT** Timeline for Chetco River Gravel Mining Permit Decision Process - 19 Oct 09 **DRAFT**											
Task	Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10
RGP/GP Permit Process											
Continue Prep of RGP/GP				15-Jan							
COE/DSL Joint Public Notice (30dy)											
Public Informational Mtg (date TBD)*	* Required for DEQ Cert process										
Review Cmts/Revise RGP/GP											
Final Decision										1-Jul	
Adaptive Management Process**							15-Apr		30-Jun		
CZM Determination											
COE sends CZM letter to DLCD					mid mnth						
DLCD Prep Consistency Det						30 days					
DLCD Public Review Process		DLCD participates in interagency public mtg					30 days				
Issue CZM Decision									30-Jun		
Water Quality Certification											
DEQ Prep WQ Decision											
DEQ Public Review (35 Days)			public review period includes time for public meeting								
Issue WQC Decision									30-Jun		
ESA Consultation											
Prep BA package/Request Consult				15-Jan							
NMFS Review of BA				15-Jan	15-Feb						
Formal Consultation Process					15-Feb			15-May			
NMFS Issues BiOp								15-May	30-Jun		
FWS Coordination Act											
Coordination Process											
FWS Comment on Public Notice											
	** Adaptive Management Process (for Operation 2010):										
	1) Assess flows for 2009/2010 (question for USGS - conduct in April?)										
	2) LIDAR to assess removal, if flows sufficient (this is done prior to July 1) - Baseline LIDAR is Sept 2008 data										
	3) Removal decision (cy per location) based on review of Items 1 and 2 - (by July 15?)										

From:	Kleibacker, Megan
To:	Achterman, Gail; Ewing, Amy Anne - ONID; kevin.moynahan@state.or.us; richangstrom@ocapa.net; Petersen, Erik S NWP; Kleibacker, Megan; Giannico, Guillermo - FW; oconnor@usgs.gov; CDL@lidstone.com; Brian.Cluer@NOAA.GOV; dennis@stillwatersci.com; tullosd@engr.orst.edu; Klingeman, Peter C.; Kim.Kratz@noaa.gov; Linton, Judy L NWP; jon.p.germond@state.or.us; ken.phippen@noaa.gov; Monty_Knudsen@fws.gov; Janine_M_Castro@fws.gov; Chuck.Wheeler@noaa.gov; jay.charland@state.or.us; lori.warner-dickason@state.or.us; byocum@hughes.net; patty.snow@state.or.us; relayer@twcontractors.com; tedf@hughes.net; todd.a.confer@state.or.us; liverman.alex@deq.state.or.us; Joy@UmpquaSand.com; bob.lobdell@state.or.us; Jim_Thrailkill@fws.gov; Rob_Burns@fws.gov; nina.deconcini@state.or.us; PUENT.Sally@deq.state.or.us; Burris, Frank; cedelnorte@ucdavis.edu
Subject:	Aggregate Workshop- Agenda and pre-workshop Materials
Date:	Monday, November 23, 2009 9:44:12 AM
Attachments:	Aggregate Mining - Agenda.doc gravel workshop questions Oct 09.doc USGS - Channel Change and Bed Material Transport in the Lower Chetco River Oregon.pdf Workshop Background Paper_ChetcoR_Jun09.doc Aggregate Workshop Attendees.xls

*I apologize to the panelists and organizers who have already received this information.

Thank you for your RSVP to the Regional General Permit- Aggregate Workshop

12:00 PM Monday, Nov 30 – 5:00 PM Tuesday, Dec 1

South Slough National Estuarine Research Reserve <http://www.oregon.gov/DSL/SSNERR/index.shtml>

In preparation for next week's workshop, attached you will find:

- Workshop agenda
- USGS Study
- Workshop Background
- Questions for the panel
- List of workshop attendees

If you have any questions please let me know. Have a great Thanksgiving and I'll see you at South Slough next Monday,

Megan

Megan Kleibacker

Watershed Education Program Associate

OSU Sea Grant Extension

307 Ballard Extension Hall

Corvallis, OR 97331-3604

541-737-8715

megan.kleibacker@oregonstate.edu <mailto:memegan.kleibacker@oregonstate.edu>

Regional Gravel Initiative Workshop

South Slough National Estuarine Reserve • 30 November - 1 December, 2009

Day 1 • Monday, 30 November

12:00 ◦	**Check-in**
12:30 ◦	**Welcome:** history of process and expectations for the future *Erik Petersen, US Army Corps of Engineers & Kevin Moynahan, Department of State Lands*
1:00 ◦	**Goals:** overview of workshop expectations; introduction of technical questions; identification of main workshop goals
1:30 ◦	**Background:** The Chetco River *Frank Burris, Oregon Sea Grant and OSU Extension Service*
2:00 ◦	**Presentation:** USGS Findings *Jim O'Connor, US Geological Survey*
3:00 ◦	**Facilitated Discussion:** what are data gaps and uncertainties? what are agency needs? what timeline is required for action? **Agency & Science Panels:** respond to and comment on USGS presentation **General Discussion**

Day 2 • Tuesday, 1 December

7:30 ◦	**Coffee**
8:00 ◦	**Geomorphological Panel:** *Pete Klingeman, DesireeTullos, Chris Lidstone, Brian Cluer & Jim O'Connor* **General Discussion**
10:00 ◦	**Break**
10:15 ◦	**Biological Panel:** *Jim Waldvogel, Dennis Halligan, Todd Confer & Brian Cluer* **General Discussion**
12:15 ◦	**Lunch**
1:15 ◦	**Large Group Discussion:** what issues remain?
2:15 ◦	**Small Group Break out:** what is needed to solve remaining issues?
3:45 ◦	**Break**
4:00 ◦	**Next Steps**
5:00 ◦	**Adjourn**

Institute for Natural Resources

Chetco Gravel Mining Workshop
November 30, December 1 2009

Discussion Questions for the Group

<u>Introduction and purpose:</u> The purpose of this workshop is to gather input from experts to assist the agencies in making a sound decision on future gravel removal on the Chetco River. The agencies have before them applications for a GP (DSL) and RGP (Corps) and are considering whether commercial gravel removal may continue in the Chetco system and, if so, at what levels and under what conditions.

DSL, the Corps and other agencies are reviewing and assessing information to make informed decisions on the GP/RGP applications. The agencies have been working collaboratively with the gravel industry (OCAPA and individual operators) in this effort. The intent of the process is to determine if gravel removal from the system is permittable based on recruitment of material into and through the system and any impacts to habitat, water quality, or other resources from material extraction. If gravel extraction is permittable, the agencies will be determining appropriate permit conditions, monitoring requirements, and adaptive management approaches to govern removal activities.

The regulatory agencies will not be making final permit decisions at this workshop. The workshop is an opportunity to discuss and investigate scientific, policy and other supported concepts to better inform permit decisions.

The agencies are using a number of sources for permit review and determinations. The US Geological Survey Open File Report 2009-1163 will be used as the best available science to evaluate current conditions on the Chetco. Other sources of information will be used as relevant to this process. Although the USGS report focuses on the physical conditions of the river, the agencies will be using this information as indirect indicators of the biological characteristics.

The Tech Team developed the following questions:

1. What does the USGS report tell us about the current condition of the Chetco overall and of the 5 reaches specifically?

The purpose of this question is to set the stage for the workshop and discuss the physical attributes of the Chetco overall and of the 5 reaches specifically.

2. What indicators are most important for assessing the health of the river and its habitat for fish? (Indicators to consider are things like the degree of incision, bar armoring, coarsening of bed material, channel sinuosity and rate or frequency of channel migration and size and location of the gravel bars)

a) Are there specific indicators that would be more relevant to the estuarine reach?

The purpose of this question is to hone in on the 3-5 indicators that could be evaluated to assess the health of the river with respect to habitat condition.

3. Considering what the USGS study indicates about gravel recruitment on the Chetco and the proposal to extract gravel,

a) Does the system require a "recovery period" to restore a balance to the system?
b) Are there any specific reaches that might require a "recovery period" to restore a balance to the system?
c) If so, should gravel extraction activities be authorized and, if so, under what conditions.

The purpose of this question to obtain opinions about whether gravel removal should occur given the current condition of the river.

4. The USGS study indicates the Chetco is flow limited (as opposed to supply limited) with respect to gravel recruitment, which ranges from 3,000 cubic yards at very low flow years to over 150,000 cubic yards in high flow years. The Tech Team is considering using flow data and the model to estimate annual recruitment. If flows are of a certain minimum velocity (tbd), a percentage (also tbd) of the recruited material may be removed from the system.

a) Does this seem like a reasonable approach to address extraction volumes for the entire system?
b) If so, how might we derive the percentage that is available for extraction?
c) LIDAR would be used to assess where the material is deposited and each operator will be allowed a certain volume based on this distribution. Does this seem like a reasonable approach to address the allocation of extraction volumes for each location on the river?
d) Is there another method that can be used to reliably estimate annual recruitment and develop a process allowing extraction of some percentage of that volume?
e) The purpose of this question is to get feedback from the experts about our approach to determining how much and where material may be extracted on an annual basis.

5. The agencies are considering employing adaptive management to determine whether gravel can be extracted and how much extraction should be allowed in any given year. In addition to employing the flow data and LIDAR above, this would involve evaluating physical and or biological indicators to assess the condition of the river and the potential for extraction activities. Some of the indicators to consider are listed below.

a) Which ones may be appropriate to consider for the annual extraction decision?
b) Which ones may be more appropriate for a periodic (5 year) review?

c) Are there other physical or biological indicators that would assist the agencies in determining whether, how much and from what location gravel may be extracted from the system?

Potential indicators include:

- Recurrence of transporting flows (via stream gauges and rainfall)
- The degree of incision
- The degree of bar armoring
- The degree of coarsening of bed material
- The degree of sinuosity of the channel (especially at the Mill Creek/North Fork reach)
- The rate or frequency of channel migration
- Size and location of the gravel bars
- Loss or gain of pool/riffle complexes
- Loss or gain of overhanging vegetation
- Presence/absence of target species
- Improvement or degradation of local water quality (e.g., temp, sedimentation, turbidity, DO, pH)

6. Are there any active management techniques (e.g., mechanical movement of existing sediment at specific locations) that could be employed to enhance, maintain, or restore system health?

7. What extraction techniques and conditions could be employed that would conserve habitat/water quality and support the health of the system?

8. What is the effect on the system if gravel and other removal activities are not permitted? The USGS report indicates the potential for aggradation at points in the system, especially at the wide, flat reaches near Millcreek/No. Fork. How would this benefit or impact habitat, water quality, flooding, recreational fishing and navigability? Can adaptive management address both benefits and impacts?

Prepared in cooperation with the U.S. Army Corps of Engineers

Channel Change and Bed-Material Transport in the Lower Chetco River, Oregon

By J. Rose Wallick, Scott W. Anderson, Charles Cannon, and Jim E. O'Connor

Open-File Report 2009–1163

U.S. Department of the Interior
U.S. Geological Survey

Cover: Chetco River gravel bars (photograph by Jim O'Connor, U.S. Geological Survey, September 2008)

Prepared in cooperation with the U.S. Army Corps of Engineers

Channel Change and Bed-Material Transport in the Lower Chetco River, Oregon

By J. Rose Wallick, Scott W. Anderson, Charles Cannon, and Jim E. O'Connor

Open-File Report 2009–1163

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
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Suggested citation:
Wallick, J.R., Anderson, S.W., Cannon, Charles, and O'Connor, J.E., 2009,
Channel change and bed-material transport in the lower Chetco River, Oregon:
U.S. Geological Survey Open-File Report 2009–1163, 83 p.

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Conversion Factors

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	Inch (in.)
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
	Area	
square meter (m^2)	10.76	square foot (ft^2)
square kilometer (km^2)	0.3861	square mile (mi^2)
	Volume	
cubic meter (m^3)	0.0008107	acre-foot (acre-ft)
cubic meter (m^3)	35.31	cubic foot (ft^3)
cubic meter (m^3)	1.308	cubic yard (yd^3)
liter (L)	0.03531	cubic foot (ft^3)
	Flow rate	
cubic meter per second (m^3/s)	35.31	cubic foot per second (ft^3/s)
cubic meter per year (m^3/yr)	1.308	cubic yard per year (yd^3/yr)
meter per second (m/s)	3.281	foot per second (ft/s)
meter per year (m/yr)	3.281	foot per year (ft/yr)
millimeter per year (mm/yr)	0.0397	inch per year (in/yr)
kilogram per meter per second	4.486	pound avoirdupois per foot per second (lb/ft/s)
	Mass	
kilogram (kg)	2.205	pound avoirdupois (lb)

Datums

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).
Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).
Elevation, as used in this report, refers to distance above the vertical datum.

Abbreviations and Acronyms

BAGS	Bedload Assessment in Gravel-bedded Streams
BLM	Bureau of Land Management
GPS	global positioning system
HEC-RAS	Hydrologic Engineering Center's River Analysis System
MLLW	mean lower low water
RMSE	root mean square error
RTK	real-time kinematic
USFS	U.S. Forest Service
USGS	U.S. Geological Survey

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By J. Rose Wallick, Scott W. Anderson, Charles Cannon, and Jim E. O'Connor

Abstract

The lower Chetco River is a wandering gravel-bed river flanked by abundant and large gravel bars formed of coarse bed-material sediment. The large gravel bars have been a source of commercial aggregate since the early twentieth century for which ongoing permitting and aquatic habitat concerns have motivated this assessment of historical channel change and sediment transport rates. Analysis of historical channel change and bed-material transport rates for the lower 18 kilometers show that the upper reaches of the study area are primarily transport zones, with bar positions fixed by valley geometry and active bars mainly providing transient storage of bed material. Downstream reaches, especially near the confluence of the North Fork Chetco River, have been zones of active sedimentation and channel migration.

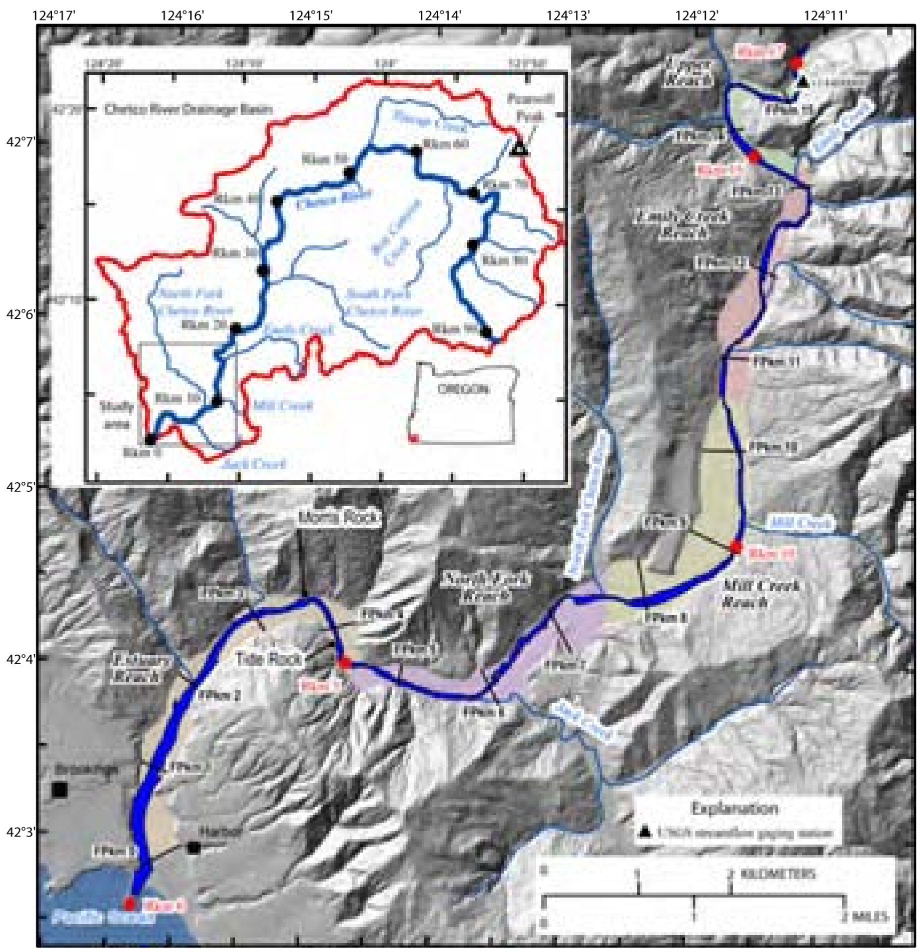
Multiple analyses, supported by direct measurements of bedload during winter 2008–09, indicate that since 1970 the mean annual flux of bed material into the study reach has been about 40,000–100,000 cubic meters per year. Downstream tributary input of bed-material sediment, probably averaging 5–30 percent of the influx coming into the study reach from upstream, is approximately balanced by bed-material attrition by abrasion. Probably very little bed material leaves the lower river under natural conditions, with most of the net influx historically accumulating in wider and more dynamic reaches, especially near the North Fork Chetco River confluence, 8 kilometers upstream from the Pacific Ocean.

The year-to-year flux, however, varies tremendously. Some years probably have less than 3,000 cubic meters of bed-material entering the study area; by contrast, some high-flow years, such as 1982 and 1997, likely have more than 150,000 cubic meters entering the reach. For comparison, the estimated annual volume of gravel extracted from the lower Chetco River for commercial aggregate during 2000–2008 has ranged from 32,000 to 90,000 cubic meters and averaged about 59,000 cubic meters per year. Mined volumes probably exceeded 140,000 cubic meters per year for several years in the late 1970s.

Repeat surveys and map analyses indicate a reduction in bar area and sinuosity between 1939 and 2008, chiefly in the period 1965–95. Repeat topographic and bathymetric surveys show channel incision for substantial portions of the study reach, with local areas of bed lowering by as much as 2 meters. A specific gage analysis at the upstream end of the study reach indicates that incision and narrowing followed aggradation culminating in the late 1970s. These observations are all consistent with a reduction of sediment supply relative to transport capacity since channel surveys in the late 1970s, probably owing to a combination of (1) bed-sediment removal and (2) transient river adjustments to large sediment volumes brought by floods such as those in 1964, and to a lesser extent, 1996.

Introduction

The Chetco River is a steep gravel-bed river in southwestern Oregon draining 914 square kilometers (km^2) of the rugged Klamath Mountains before entering the Pacific Ocean 5 kilometers (km) north of the California–Oregon State line (fig. 1). Downstream of the confluence of the South Fork Chetco River at river kilometer (Rkm) 29, the Chetco River is flanked by varying widths and areas of gravel bars and floodplains. Downstream of Rkm 18, several of these gravel bars have been mined as a source of aggregate for the last century. Ongoing permitting actions have instigated questions of possible effects from such mining on physical channel conditions (for example, Kondolf, 1994, 1997), prompting the U.S. Army Corps of Engineers, in conjunction with regulatory agencies and stakeholder groups, to request from the U.S. Geological Survey (USGS) a measurement and analysis program to evaluate transport rates of bed material and to assess changes in channels and floodplains for the lower 18 km.



Base map modified from Oregon LIDAR Consortium digital data.
UTM projection, Zone 10
Horizontal datum, North American Datum of 1983

Figure 1. Map showing watershed and study area, Chetco River, Oregon. Morris Rock and Tide Rock are informal names for prominent local landmarks. Topography based on U.S. Geological Survey 10-m digital elevation data and 2008 LIDAR topography. Rkm, river kilometer; FPkm, floodplain kilometer.

Purpose and Scope

This report summarizes analyses of temporal trends in channel width and gravel bar area, and bed-material transport measurements and calculations, with the goal to estimate temporal and spatial trends in bedload transport, deposition, and erosion within the lowermost 18 km of the Chetco River, and further to assess historical changes to the channel and floodplain. These analyses were supported by systematic mapping of channels and floodplains from historical and current aerial photographs, sampling of bed-material size distributions, bedload transport measurements and hydraulic modeling. Additionally, the channel mapping in conjunction with new surveys allows for assessment of planform and vertical changes in channels, possibly attributable to changes in sediment balances and transport. The scope of the study follows from a process established in the State of Oregon to address permitting issues for inchannel gravel extraction.

Background

The Chetco River is like many western U.S. rivers for which issues of fish habitat, water quality, climate change, and changing land use have motivated new efforts to manage rivers and floodplains for multiple resources. Within Oregon, rivers potentially subject to inchannel gravel extraction undergo a two-phase process of review and assessment by an interagency team co-chaired by the U.S. Army Corps of Engineers and the Oregon Department of State Lands, and subdivided into an executive team of policy managers and a technical team of supporting resource experts. The first phase is a preliminary assessment of “vertical stability” based primarily on available information. If Phase I analysis shows no clear evidence of adverse channel or floodplain conditions, a Phase II analysis may be initiated to provide more information relevant to permitting decisions. For the Chetco River, this Phase I assessment was completed in May 2007 (Janine Castro, U.S. Fish and Wildlife Service, written commun., 2007). This assessment of maps and surveys concluded that although the lowermost 2 km of the river “appears to have deepened slightly over the past 20 years,” there was no evidence of systematic channel incision for the balance of the lower 18 km of the Chetco River. These findings prompted the executive team to consider permitting of future instream gravel extraction upon completion of a more extensive Phase II analysis consisting of data acquisition and analysis aimed at:

1. Determining spatial and temporal rates of bed-material transport.
2. Assessing planform and vertical changes to the river channel.

In addition to these specific Phase II analysis components, the USGS was requested to provide broadscale maps of floodplain geomorphology and general vegetation along the floodplain flanking the lower 18 km of the river corridor. The lower 18 km forms a convenient analysis segment because the upstream end approximately corresponds to the USGS streamflow measurement station for the Chetco River 16.9 km upstream from the mouth and encompasses the extent of commercial gravel extraction. These findings and maps will be used by the regulatory agencies as supporting information for future permitting decisions for instream gravel extraction along the Chetco River.

Our approaches for assessing channel changes, as well as mapping current and historical channels and vegetation, followed established procedures of aerial photograph analysis, and channel and floodplain surveys. Our analysis period extends back to include aerial photographs and bathymetric surveys from 1939. Assessing sediment transport rates and budgets is more difficult (Reid and Dunne, 1996, 2003), particularly for bed material (Edwards and Glysson, 1999; Hicks and Gomez, 2003; Reid and Dunne, 2003). Because of the challenges in assessing bed-material transport rates, we have adopted several measurement, modeling, and analysis approaches to ensure the greatest likelihood of meaningful results and to provide qualitative assessment of their accuracy.

Units and Locations

All analyses and results are presented in metric units. Conversions to English units are provided in the report front matter. Locations along the channel alignment in summer 2008 are referenced to river kilometers (Rkm) measured from the Chetco River mouth along the channel centerline mapped from Light Detection and Ranging (LIDAR) topography acquired in 2008. Ambiguity because of channel shifting was avoided by referencing locations and analyses for the lowermost 18 km to a floodplain centerline (FPkm), measured from the river mouth along the centerline of the Holocene floodplain (fig. 1). In 2008, approximately 18 km of channel were within the 16-km-long length of floodplain composing the study reach. Prominent landmarks and locations include the Highway 101 bridge at FPkm 0.9 (Rkm 1.4), Tide Rock at FPkm 4.2 (Rkm 4.9), North Fork Chetco River confluence at FPkm 7.6 (Rkm 8.3), and the USGS streamflow measurement station (at Second Bridge) at FPkm 15.2 (Rkm 16.9).

The Chetco River

The Chetco River drains 914 km^2 of southwestern Oregon and empties into the Pacific Ocean 5 km north of the California-Oregon border (fig. 1). Major tributaries are Tincup Creek (Rkm 54), South Fork Chetco River (Rkm 29), and North Fork Chetco River (Rkm 8.3; FPkm 7.6). In 1988, the Chetco River between Rkm 16 and 88 was designated as “Wild and Scenic” as part of the National Wild and Scenic River program. The eastern half of the drainage basin is within the Kalmiopsis Wilderness Area, established in 1964. At its entrance to the Pacific, the river separates the coastal communities of Brookings and Harbor. The drainage basin is wholly contained within Curry County, Oregon.

Geography and Geology

The drainage basin is steep and rugged. The highest point is Pearsoll Peak at 1,554 m, and the lowest elevation is sea level at the river mouth. The average basin slope is 0.42 m/m as measured from 10-m resolution digital elevation data. Drainage density, as measured from the 1:24,000 National Hydrologic Data set is 1.4 km/km^2. The Chetco River itself is 88 km long, heading at an elevation of 540 m and descending to sea level at an average gradient of 0.006 m/m, but most elevation loss is in the upper half of the drainage basin, leaving the lowermost 38 km with a gradient of 0.0013.

The drainage basin is within the Klamath Mountains physiographic province, an amalgamation of several geologic terranes affixed to western North America during the late Mesozoic and early Tertiary in a progression of eastward dipping underthrusts. During accretion and subsequently, the rocks have been metamorphosed and intruded by igneous plutons, dikes, and sills, chiefly of Cretaceous and Tertiary age. The degree of metamorphism and igneous intrusive activity decreases westward, with most of the highly deformed metamorphic rock and intrusive igneous rocks forming the steeper and higher eastern part of the drainage basin, mainly upstream of Rkm 70. The western half of the basin is dominated by the Dothan Formation, which consists mainly of slightly metamorphosed greywacke sandstone and siltstone with minor amounts of volcanic rocks and chert (Ramp, 1975; Orr and others, 1992).

The steep slopes, high drainage density, and high gravel transport rates result from the combined effects of geologically recent uplift and erodible rock types. Analysis of uplifted 80–120 kiloannum (ka) shore platforms indicate late Quaternary uplift rates as high as 1 mm/yr (Kelsey and others, 1994), whereas geodetic and tidal observations suggest even higher historical rates of 2.5–3.5 mm/yr (Burgette and others, 2009). The rapid uplift has facilitated river incision and landsliding, especially in the upper drainage basin (Ramp, 1975).

The lower river valley, particularly along the lowermost 18 Rkm, has been strongly affected by the 130 m of sea-level rise since the culmination of the last maximum glacial period 18,000 years ago. Along the Oregon coast, rising sea levels have drowned river valleys incised during low stands of sea level, creating estuaries now extending inland from the coast. With the onset of sea-level rise, and especially during the last 2000 years of relatively stable sea level, these drowned river valleys have been filling with fluvial sediment (Komar, 1997, p. 30–32). For the Chetco River, the wide valley bottom of the lowermost 10 km is the result of this valley filling. Tidal effects extend 5 km inland, evidence that filling of the lower river valley has not yet matched Holocene sea level rise, and that the river has not yet attained a graded profile to the coast.

Hydrology

As described by early U.S. Army Corps of Engineers (1893, p. 3,431) navigation engineers, “Above the head of tide the [Chetco] river runs nearly dry in the summer, and is at all times but a small mountain stream, which becomes a torrent from the winter storms.” The combination of rugged physiography, high drainage density, and high rainfall associated with a Pacific marine climate results in high annual runoff values and flashy short-duration peak flows, but very low summer flows. Average rainfall in the drainage basin is about 2.4 m (Soil Conservation Service, 1979), ranging from about 2 m/yr at Brookings and increasing with elevation to nearly 4 m/yr in the basin headwaters (Maguire, 2001, p. 116). Eighty percent of the precipitation falls during October through March, mostly resulting from 2- to 4-day Pacific frontal systems impinging from the southwest.

Flow has been measured at the USGS streamflow gaging station (14400000; Chetco River near Brookings) at FPkm 15.24 since October 1, 1969. For water years (October 1–September 30) 1970 through 2008, mean annual flow has been 64 m^3/s, equating to 0.75 m of runoff from the contributing area above the measurement station. Measured annual peak flows have ranged from 280 m^3/s in 2001 to 2,169 m^3/s in 1996; although the 1964 peak is estimated to have been 2,420 m^3/s. The mean annual peak flow is 1,085 m^3/s (fig. 2).

To extend the record of peak flows to encompass the 1939–2008 analysis period, we estimated peak flows in the decades prior to 1970 on the basis of a linear regression between the Chetco River gaging station (14400000) and the USGS streamflow gaging station on the Smith River (11532500), near Crescent City in northern California and in operation since October 1931 (fig. 2A). Although the Smith River drainage basin, at 1,590 km^2, is 74 percent larger than the Chetco River drainage basin, both are coastal drainage basins within the Klamath Mountains physiographic province subject to similar hydrological conditions.

The reconstructed peak flow history for the Chetco River shows a pattern of increasing annual peak flows during 1931–72, with typical values ranging from 700 m^3/s in the 1930s to approximately 1,400 m^3/s by 1970 (fig. 2). Floods in the 1950s (particularly the 1955 peak flow event) appear similar in magnitude to the recent floods of 1971 and 2006, consistent with anecdotal records (Soil Conservation Service, 1979) that describe widespread flooding and damage associated with each of these events. Large floods with discharges exceeding 2,000 m^3/s are much less common, and for the last 100 years have occurred only in 1964 and 1996, although historical records indicate similar, if not larger, peak discharges during the large regional floods of 1861 and 1890 (Maguire, 2001). The estimated peak flows for 1931–69 do not show the extremely low values (less than 500 m^3/s) such as those in 1977 and 2001, although the regional drought in the 1930s coincides with generally lower annual peak flows for the period 1930-40.

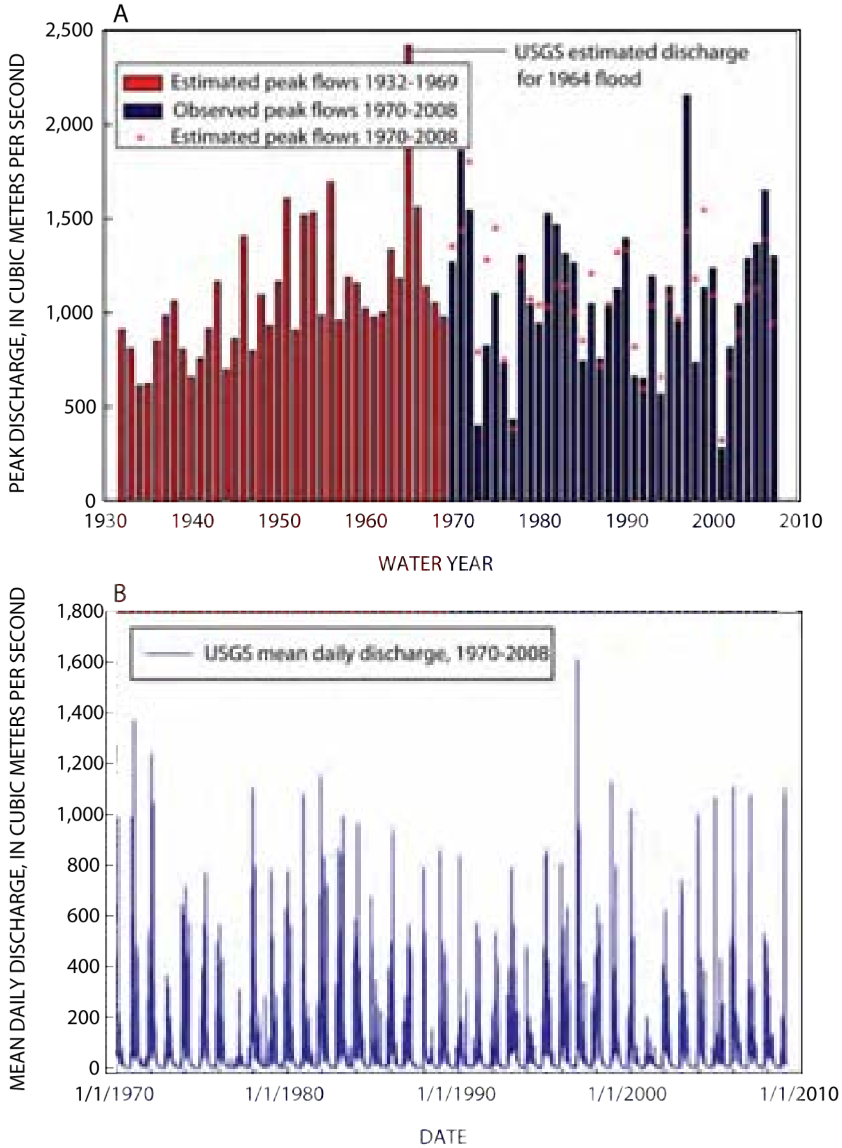


Figure 2. Graphs showing flow records for USGS streamflow gage 14400000, Chetco River near Brookings, Oregon.. A. Estimated and observed annual peak flows for water years 1930-2008. B. Mean daily discharge for water years 1970–2008. Annual peak flows; measured for water years 1971-2008, estimated for 1964 on basis of high water mark and extension of rating curve, and estimate for all other years on basis of Smith River USGS streamflow gage (11532500) in northern California. Estimates from Smith River record were determined by regression of log-transformed values on period of overlap for which *Log Chetco River* Q_{peak} *= 0.6337 * (Log Smith River* Q_{peak}*) + 1.4708* (r = 0.83).

The Study Area

Our analysis focused on the lower 16 km of the Chetco River floodplain (fig. 1). The overall planform within the study area is that of a “wandering gravel-bed river” (Church, 1983) dominated by a single channel but also having multichanneled reaches. The channel generally alternates position against opposite valley walls, forming deep scour pools where it flows against valley walls and shallow riffles where it crosses the valley floor between large gravel bars (Klingeman, 1993). The location and general shape of many of the expansive gravel bars (fig. 3) flanking the low flow channel are fixed by the control of valley geometry on high-stage flow hydraulics and consequent patterns of erosion and deposition. Within the study reach, the low flow channel as mapped in 2008 has an average slope of 0.0012 between FPkm 16 and FPkm 4.3, and a much flatter gradient in the tidally affected lower river and estuary. The channel has a distinct pool-riffle morphology above FPkm 4.5 (fig. 4).

Figure 3. Map showing example of alternate bar sequence near flood plain kilometer 11, Chetco River, Oregon. Digital orthophotograph from 2005 depicts large, channel-flanking gravel bars and low-flow channel. Flow is to the south. FPkm, floodplain kilometer.

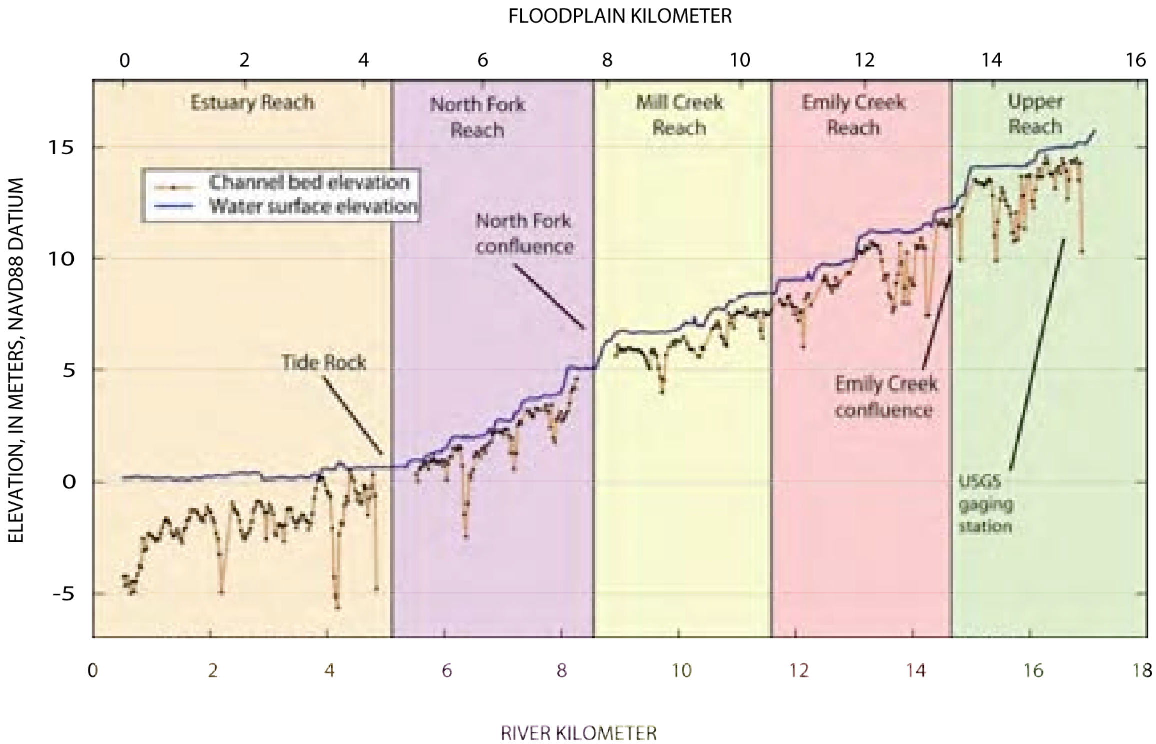


Figure 4. Graph showing water surface and bed profile along study area, Chetco River, Oregon. USGS thalweg survey during autumn 2008; water surface from LIDAR topography, flown in May–June 2008.

Longitudinal patterns in gravel transport and channel change in the study area were characterized by dividing the area into five reaches of inferred similar transport on the basis of valley geomorphology, slope, and tributary locations (figs. 1 and 4, table 1). The Upper Reach (FPkm 13.2–16) extends from the upstream end of the study area to the Emily Creek confluence, and is the most confined of all five reaches with an average floodplain width of 215 m. The valley and channel widen slightly through the Emily Creek Reach (extending between the confluences of Emily Creek and Mill Creek, FPkm 13.2–10.6). The Mill Creek Reach (FPkm 10.6–7.6) encompasses the transition from the more stable upper reaches to the wider, more dynamic lower reaches, with floodplain width increasing to 800 m as the Chetco River approaches its confluence with the North Fork of the Chetco River. The valley is widest along the lower portion of the Mill Creek Reach and the North Fork Reach (FPkm 7.6–4.3), before narrowing and abruptly flattening as it enters the Estuary Reach, which corresponds to the tidally influenced zone from FPkm 4.3 (near the prominent local landmark of Tide Rock) to the mouth of the Chetco River (FPkm 0).

Table 1. Summary of reach attributes for the study area, Chetco River, Oregon.

[Abbreviations: m, meter; FPkm, floodplain kilometer]

Reach name	Distance along floodplain axis	General description	Average water surface slope (2008) (m/m)	Average floodplain width (m)	Average width of low-flow channel (2008) (m)	Instream gravel extraction sites 1995-2008
Upper Reach	FPkm 13.2–FPkm 16	Steep, narrow channel corridor where channel and gravel bars have remained fairly stable over time	0.00138	213	45	Fitzhugh Bar (FPkm 15.4), operated by Tidewater Contractors Inc.
Emily Creek Reach	FPkm 10.6–FPkm 13.2	Similar planform and stability as Upper Reach, but wider valley bottom and increasing bar size.	0.00109	285	48	Tamba Bar (FPkm 11), operated by South Coast Lumber Co.
Mill Creek Reach	FPkm 7.6–FPkm 10.6	Transition reach between the stable upper reaches and more dynamic North Fork Reach	0.00072	474	56	-
North Fork Reach	FPkm 4.3–FPkm 7.6	Historically most dynamic of all reaches. Extensive in-stream gravel mining at multiple sites since 1930s.	0.00140	343	47	North Fork site (FPkm 7–7.8), operated by Freeman Rock Inc.
Estuary Reach	FPkm 0–FPkm 4.3	Tidally influenced, confined between steep valley walls. Mouth of river historically was historically dynamic but navigation improvements have stablized channel entrance. Extensive gravel mining along multiple sites prior to 1990s.	0.00015	329	96	Estuary Bar (FPkm 2.8), operated by Tidewater Contractors Inc.

Land-Use and Landscape Disturbance in the Chetco River Basin

Because of its rugged topography and remote location, the Chetco River basin was largely uninhabited until the early 20th century, and even today most of the drainage basin is publically owned and managed as forest lands and wilderness. Late in the 19th century, the U.S. Army Corps of Engineers (1893, p. 3,432) reported that “probably not over 100 people living in the whole Chetco Valley.” By the 1930s, individuals and lumber companies were logging on private lands along tributary valleys in the lower drainage basin (Chetco Watershed Council, 1995). Logging activity expanded to the upper basin during the peak harvest period of the 1950s–1960s and then steadily declined through the 1990s (John P. Williams, U.S. Department of Agriculture Forest Service, written commun., April 28, 2009). As of 2001, 97 percent of the Chetco River basin is managed as forest lands and wilderness by the U.S. Forest Service (USFS), Bureau of Land Management (BLM), and to a lesser extent, private timber companies (Maguire, 2001). More than half of the basin (521 km^2), including much of the headwaters, is in the

Kalmiopis Wilderness Area. Other important land uses in the middle and lower basin include agriculture, rural residential development, and gravel quarries, which in total cover 2 percent of the total basin area, whereas urban areas near the mouth of the Chetco River occupy only 1 percent of the basin (Maguire, 2001).

Forest Management and Fire

Although a variety of natural and anthropogenic disturbances may influence channel conditions along the Chetco River, those likely to have the greatest effect in terms of sediment transport and channel planform along the study are watershed-scale disturbances such as floods, logging (and related) activities, forest fires; and activities within the study reach, including navigation improvements to the estuary, development and bank protection, and instream gravel mining. Logging and associated road building can increase peak flows (Wemple and others, 1996; Jones and Grant, 1996, 2001; Bowling and others, 2000) and the frequency of landslides (Kelsey and others, 1995), resulting in sedimentation along lower reaches of affected basins (Madej, 1995). Although data describing historical logging practices, road building, and resultant landscape change are sparse for the Chetco River, it is possible that the period of peak logging in the 1950s–1960s may have affected sediment influx into the lower Chetco River.

In recent decades, two large regional fires burned portions of the upper Chetco basin. The Biscuit Fire of summer 2002 was one of the largest historical forest fires in the Klamath Mountains, burning more than 57 percent of the Chetco River drainage basin with varying severity. In many places within the upper drainage basin, the Biscuit Fire overlapped with areas previously burned by the 1987 Silver Fire, although the Silver Fire only burned 10 percent of the basin (U.S. Forest Service, 2008). Possible long-term effects on Chetco River channel conditions resulting from the Biscuit Fire include enhanced runoff and erosion resulting from loss of vegetation (U.S. Forest Service and Bureau of Land Management, 2004), leading to downstream sedimentation.

Navigation Improvements

The Chetco River estuary is one of the smallest estuaries in Oregon, with a tidal prism extending only 4.6 km upstream from the Pacific Ocean, and its lateral extent constrained between steep valley walls (Ratti and Kraeg, 1979). Although the U.S. Army Corps of Engineers (1893, p. 3,431) originally declared that "the Chetco River estuary was unworthy of improvement" because of its small size and lack of regional commerce, expansion of the wood products industry and commercial fishing resulted in authorization of a series of navigational improvements as part of the 1945 River and Harbor Act (Slotta and Tang, 1976; Ratti and Kraeg, 1979). By 1959, a pair of jetties had been constructed at the mouth of the river, and an entrance channel dredged through the bar that had historically blocked seasonal entrance to the estuary. Navigation and harbor improvements continued through the 1960s and 1970s, with the dredging of two boat basins in former tidelands areas and construction of a protective dike (Slotta and Tang, 1976; Ratti and Kraeg, 1979). These alterations were accompanied by filling of a historical lagoon by the Port of Brookings to reduce flooding and improve access to the moorages (Oregon Department of State Lands, 1972).

Since the early 1960s, the U.S. Army Corps of Engineers dredged each year to maintain the entrance to the Chetco River channel, removing an average of 22,000 m^3/yr (Judy Linton, U.S. Army Corps of Engineers, written commun. February 23, 2009; fig. 5). Only part of this dredged volume, however, is removed from the lowermost kilometer of the Chetco River, with the balance removed downstream of the jetties at the entrance to the channel. Additionally, it is uncertain how much of this dredged sediment, even that within the lowermost river, is derived from downstream river transport rather than marine transport into the lower Chetco River. For similar Oregon estuaries of the Yaquina and Alsea Rivers, most sand at the river mouth is of marine origin (Kulm and Byrne, 1966; Peterson and others, 1982). For the similarly sized (725 km^2) Redwood Creek in northern California, Ricks (1995) showed that the sand in the estuary has a composition more similar to nearby Pacific beaches than that from the Redwood Creek drainage basin, indicating that a substantial portion of the Redwood Creek estuary sand is from marine transport into the estuary.

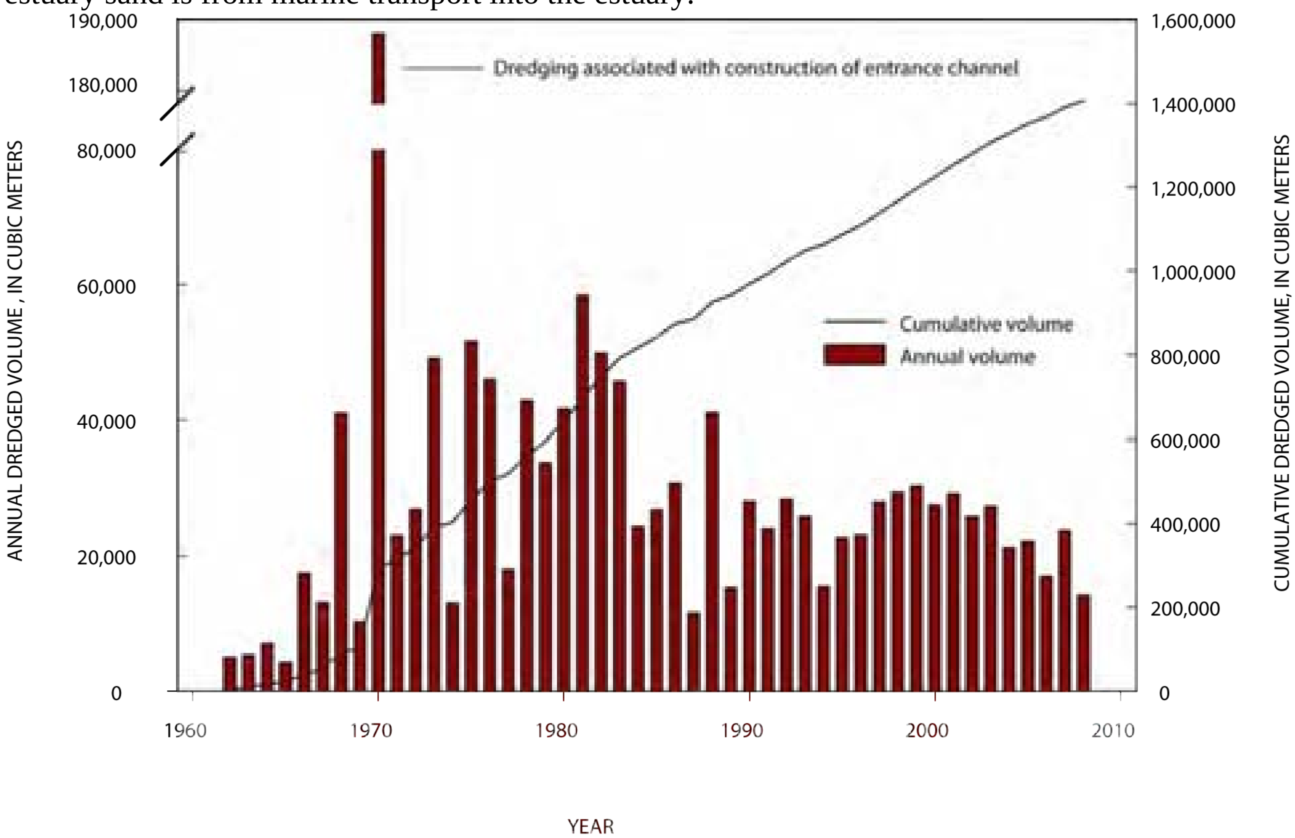


Figure 5. Graph showing annual navigational dredging volumes, 1962-2008, Chetco River, Oregon. Dredging began in 1962 and maintains navigation clearance at the river mouth and the boat basin. Data source: Judy Linton, U.S. Army Corps of Engineers, written commun., February 23, 2009.

Chetco River Gravel Mining

Sand and gravel has been mined for aggregate from bars flanking the low flow channel of the Chetco River floodplain for nearly a century. All of this removal has been downstream of FPkm 16 and has primarily been in the estuary and near the confluence of the North Fork Chetco River at FPkm 7.5. Although historical records of removal volumes and practices are incomplete, accounts from long-time residents indicate that gravel extraction began in the early 1900s when gravel was removed by drag line from the estuary, and by the 1930s, several bars below FPkm 7.5 were being mined (T. Freeman, Freeman Rock Inc., written commun., 2009). Prior to 1967, no permit was required for instream gravel extraction in the State of Oregon, and on many rivers, it was common for aggregate to be removed from deep pits that extended well below the water line. Although anecdotal accounts (M. McCabe, Oregon Department of State Lands, oral commun., 2009; T. Freeman, Freeman Rock Inc., oral commun., 2009) indicate that several operators utilized such pits along the lower Chetco River, and aerial photographs from the 1930s to 1960s show possible water-filled pits on gravel bars below FPkm 6, there are no records to better describe or quantify the volume of mining from this time period. After the 1960s, pit extraction was gradually replaced with bar “scalping” or “skimming” techniques using scrapers or other heavy equipment to remove only the surface of the gravel bar, typically to an elevation close to the low-flow water level.

On the Chetco River, removal of instream gravel for aggregate probably peaked in the 1970s and 1980s, when there were at least 15 instream gravel operators within the study area and removal volumes were much higher than during recent years. Records listing removal volumes from a small number of operators show that average annual extraction for the period 1976–1980 was approximately 140,000 m^3/yr (Marquess and Associates, 1980), a rate three times greater than that for 1993–2008 (fig. 6). In 1994, the Chetco River was declared navigable (and hence publicly owned) by the State of Oregon, and royalty fees were assessed on instream gravel extraction. Largely in response to tighter permitting conditions and fees, only three companies have continued commercial gravel extraction on the Chetco River, and the annual volume of gravel removal has declined substantially. From 1995 through 2008, instream gravel was mined at four primary sites along the Chetco River:

- ☐ Tidewater Estuary Bar (FPkm 3), operated by Tidewater Contractors Inc.
- ☐ Freeman North Fork Site (FPkm 7.5), operated by Freeman Rock Inc.
- ☐ Tamba Bar (FPkm 11), operated by South Coast Lumber Co.
- ☐ Fitzhugh Bar (FPkm 15.5), operated by Tidewater Contractors Inc.

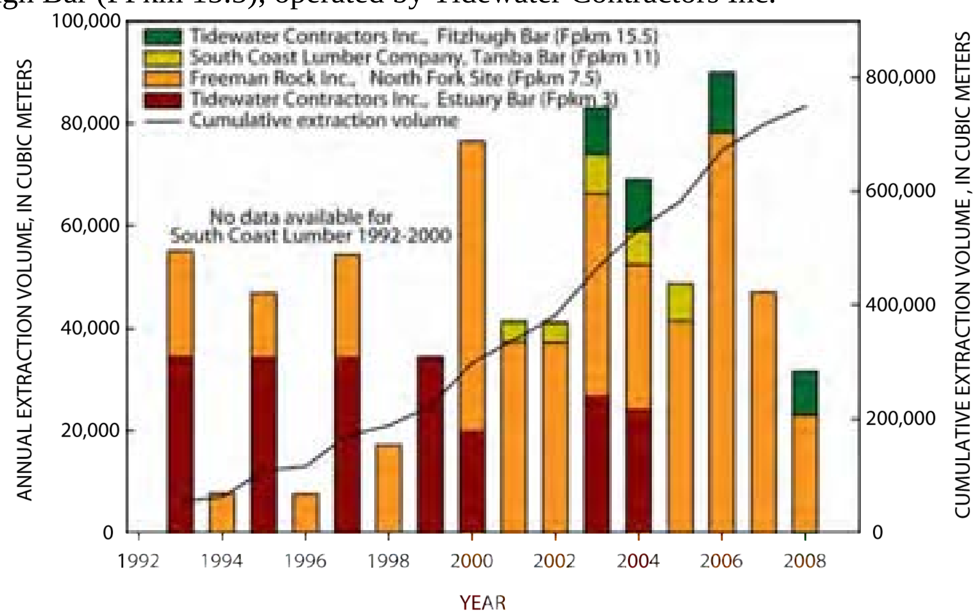


Figure 6. Graph showing instream commercial gravel mining, Chetco River, Oregon, 1993–2008. Values reported by commercial operators and corroborated with records of Oregon Department of State Lands. Values for Estuary Bar for 1993–1999 are estimates provided by Robert Elayer (Tidewater Contractors Inc, written commun., 2008).

Information provided by the gravel operators for mined volumes between 2000 and 2008 (the period for which actual extraction volumes for all operators is available) indicate that on average, nearly 59,000 m^3 of aggregate was removed annually between the three operators, with year-to-year values ranging between 32,000 m^3 (2008) to 90,000 m^3 (2006) depending on permit conditions and gravel replenishment at mining sites (fig. 6).

Valley Bottom Mapping and Analysis of Historical Channel Change

Historical and current channel maps, surveys, and aerial photographs provide a means for assessing planform and vertical changes to the Chetco River study area since the late 1930s. In this study, we document planform changes to the morphology and land-cover types of the valley bottom by analysis of multiple sets of aerial photographs dating back to 1939. Vertical changes to the channel and floodplain were assessed from sparser historical data, including 1939 and 1977 surveys, and the record of channel geometry documented at the USGS streamflow measurement station at FPkm 15.2. Current information on topography, bathymetry, and vegetation was based on (1) LIDAR topography acquired in spring 2008 and provided by the Oregon LIDAR Consortium (Oregon Department of Geology and Mineral Industries, 2009), (2) channels and estuaries surveyed in summer 2008, and (3) half-meter orthoimagery for 2005 developed from summer 2005 aerial photographs as part of the U.S. Department of Agriculture National Agriculture Imagery Program (NAIP).

Historical Changes in Channel Planform and Vegetation

Planview changes in channel morphology were quantified by mapping channel features from eight time periods using aerial photographs and the LIDAR. The time periods selected for channel mapping were chosen to track channel change for the longest possible time period and to serve as a basis for assessing erosion and deposition for five time intervals: 1939–43, 1962–65, 1995–2000, 2000–2005, and 2005–08. These times were chosen on the basis of photo availability and quality, as well as to encompass specific events possibly affecting channel morphology. The period 1939–43 represents a period of minimal land use in the Chetco River basin and little gravel extraction. The period 1962-65 includes the 1964 flood of record and also represents an era of increasing land use throughout the basin, including navigational improvements near the mouth of the Chetco River and increased gravel extraction along the lower river corridor and timber harvest within the drainage basin. The three recent time periods (1995–2000, 2000–2005 and 2005–08) postdate the era of most voluminous gravel extraction and timber harvest but encompass the two large floods of 1996 and 2006.

Acquisition and Rectification of Historical Aerial Photographs

Digital orthoimagery from 1995, 2000, and 2005 have been previously rectified and georeferenced and are in the public domain (table 2). By contrast, older sets of aerial photographs were available only as paper prints or negatives and required scanning, georeferencing, and rectification as part of this study (table 2). Coverage was complete for the entire study area for all photograph sets except for the photos from 1939 which extended only up to FPkm 13.5, leaving the upstream 2.5 km without coverage for 1939. The aerial photographs and LIDAR were all acquired during flows less than 15 m^3/s, well within the low-flow channel (tables 2 and 3).

Table 2. Aerial photographs and orthophotographs used in the sediment transport study, Chetco River, Oregon

[**Abbreviations:** m^3/s, cubic meters per second; FPkm, floodplain kilometer; USACE, U.S. Army Corps of Engineers; USFS, U.S. Forest Service; USDA, U.S. Department of Agriculture; USGS, U.S. Geological Survey; NAIP, National Agriculture Imagery Program. * Indicates estimated discharge, calculated by extending the Chetco River USGS streamflow gage data based on data from the Smith River USGS gage.]

Year	Original format	Coverage	Flight date	Approximate discharge at photo date (m^3/s)	Photo scale or orthophoto resolution	Original source	Rectification source
1939	Aerial photograph	FPkm 0-13	5/27/1939	11*	1:10,200	USACE	This study
1943	Aerial photograph	FPkm 0–16	8/3–8/4/1943	5*	1:40,000	USFS	This study
1962	Aerial photograph	FPkm 0–16	7/18/1962 for FPkm 0–4.5, 6/7/1962 for FPkm 4.5–16	11* (FPkm 4.5–16), 4* (FPkm 0–4.5)	1:8,800	South Coast Lumber Company	This study
1965	Aerial photograph	FPkm 0–16	6/22/1965	7*	1:20,000	USDA	This study
1995	Orthophotograph	FPkm 0–16	5/27/1995	15	1 pixel = 1 m	USGS	USGS
2000	Orthophotograph	FPkm 0–16	7/27/2000–8/14/2000	3–4	1 pixel = 1 m	USGS	USGS
2005	Orthophotograph	FPkm 0–16	7/17/2005	9	1 pixel = 1 m	NAIP	NAIP

Table 3. Map and survey data reviewed in the sediment transport study, Chetco River, Oregon—continued

[**Abbreviations:** FPkm, floodplain kilometer; USACE, U.S. Army Corps of Engineers; USGS, U.S. Geological Survey; GLO, General Land Office; SCS, Soil Conservation Service; LiDAR, light detection and ranging; GIS, geographic information system]

Original Source for map or survey	Type of map or survey	Date of map or survey	Date(s) survey was performed	Coverage	Comments
USACE	Navigational bathymetry map	1939	June 20–July 14, 1939	FPkm 0–4.5	Scanned, rectified and digitized by USGS staff using 1939 aerial photographs.

Table 3. Map and survey data reviewed in the sediment transport study, Chetco River, Oregon—continued

[**Abbreviations:** FPkm, floodplain kilometer; USACE, U.S. Army Corps of Engineers; USGS, U.S. Geological Survey; GLO, General Land Office; SCS, Soil Conservation Service; LiDAR, light detection and ranging; GIS, geographic information system]

GLO	Township survey	1879	September 16–October 2, 1845 and February 25–March 12, 1879	FPkm 3–11.5	Survey to delineate township and section lines; channel and gravel bar locations were surveyed at the section boundaries, with intervening areas approximated.
SCS	Flood study	1979	1977	FPkm 0–16	Cross sections converted to NAVD 88 vertical datum (this study) for comparison with 2008 data
Watershed Sciences, Inc.	LiDAR survey	Expected release in 2009	May 3–July 6, 2008	FPkm 0–16	Discharge during LiDAR flight ranged from approximately 37 m^3/sec.
USGS	Bathyemetric survey	This study	September 16 and 17, 2008	FPkm 0–3.5	Bathymetric survey of Chetco River estuary using Echosounder to produce 3–5 depth measurements per meter of survey line.
USGS	Cross-section and long profile survey	This study	October 7–9, 2008	FPkm 3–16	See accompanying GIS layers and metadata for map and survey descriptions

Full details of georeferencing and rectifying are included in the metadata for the GIS maps prepared in conjunction with this study (U.S. Geological Survey, 2009), but to summarize: The scanned historical aerial photographs were georeferenced in ArcGIS 9.2 using the orthophotographs from 2005 as a base layer and following the methodology of Hughes and others (2006). For the photographs from 1943, 1962, and 1965, we acquired 6–16 ground control points per photograph, preferentially located near the channel. A second order polynomial fit was applied to georeference the photographs, providing root mean square error (RMSE) values ranging from approximately 1 to 4.4 m. The photography from 1939 was more difficult to register because of the small area covered by each photograph (approximately 1.5 x 2 km) and the small number of feature points present in the photographs from 1939 and 2005. Consequently, the photographs from 1939 were georeferenced using only 3–6 ground control points per photograph and rectified using a first order polynomial, which resulted in RMSE values of 0.35–3.6 m. Once georeferenced, each photograph was rectified and then combined to create a seamless mosaic of images for each period.

Uncertainties and Limitations to Planimetric Mapping

Even with established protocols and spatial analysis techniques, uncertainty and error result from interpretive mapping of land-surface features from aerial photographs of varying quality and light conditions and from different time periods (Gurnell, 1997; Mount and Louis, 2005; Hughes and others, 2006). For this study, the quality and resolution of the photographs varied both spatially and temporally but was sufficient for most of our mapping objectives. The major source of mapping error for most features in this study resulted from imprecise registration and rectification of historical aerial photographs, especially for the older photos for which there were few features to use as control points. The RMSE values indicate that horizontal position uncertainties are less than 5 m; however, from test trials, we more conservatively judge positional errors for the historical aerial photographs resulting from the georeferencing and rectification process to be almost everywhere less than 20 m. Positional errors associated with the publicly available orthophotographs for 1995, 2000, and 2005 are less than 6 m. Georeferencing errors will have their greatest effect on analyses of photo-to-photo change, such as for quantitative estimates of channel movement and bar growth and erosion, but will have little influence on measurements of total areas of features such as the for the channel and gravel bars.

Another important consideration in comparing mapped features from different time periods is differences in discharge between aerial photograph sets. Although all photography and LIDAR were acquired during low-flow periods (tables 2 and 3), small changes in discharge can influence delineation of channel and bar areas, particularly in areas where the channel is wide and shallow. We partly account for this in some analyses by determining the relations of bar and channel area to flow on the basis of a one-dimensional hydraulic model and the channel and floodplain topography for 2008 (see complete model description in the Hydraulic Modeling section below). This relation (fig. 7), which indicates that as much as 15 percent of the total bar area is inundated within the range of flows in the analyzed photographs, was used to normalize the channel width and bar area measurements for all analysis periods to a constant discharge of 2.8 m^3/s, a discharge slightly less than the lowest discharge associated with any of the photography sets.

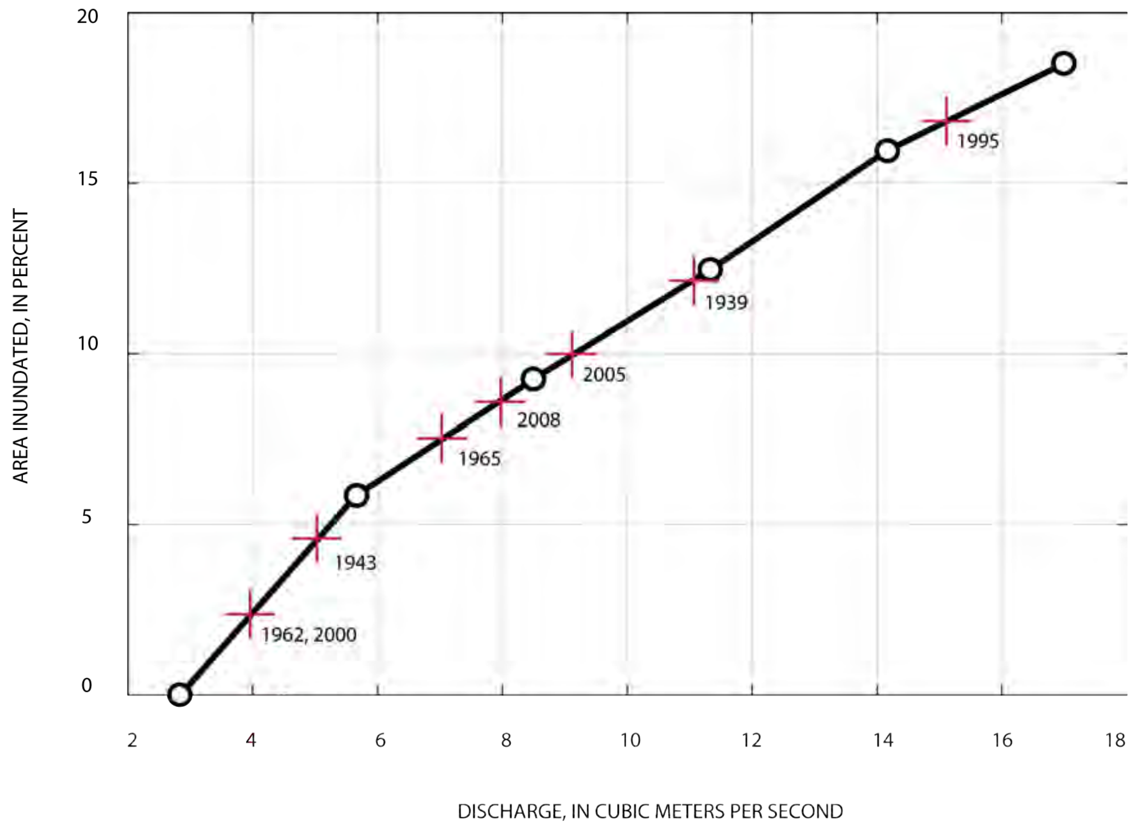


Figure 7. Graph showing relation of bar inundation with discharge, Chetco River, Oregon. Area inundated for each discharge was calculated on the basis of six modeled discharges between 2.8 and 17 cubic meters per second and overlaying corresponding inundated areas onto mapped bar areas. This relation was used to normalize bar and channel measurements from different photo sets to a common discharge of 2.8 cubic meters per second. Also shown are discharges for the seven photo sets and the LIDAR.

Tide level has an especially large influence on the mapping within the Estuary Reach, particularly for gravel bars submerged with each tidal cycle. Because tidal stage did vary between photography sets, we mapped only the portion of bars inferred to be above tidal range during low flow periods. This was possible because bars subject to daily tidal inundation have significant algal growth, giving them a distinctly darker tint in the photographs. The tidally inundated portions of the bars were included in the primary channel map unit.

In summary, considering registration errors and digitizing precision, we infer the horizontal uncertainty of the digital channel and floodplain maps to be less than 15 m for sharply defined features. For the maps from 1995 to 2008, positional uncertainty is probably less than 6 m as judged by the precise agreement between persistent features observable on this imagery. Flow variations between photography sets add additional uncertainty, but this can in part be accounted for by normalizing bar and channel area measurements to a reference discharge.

Mapping Channel Features, Floodplain Vegetation, and Bank Materials

The photograph mosaics provide the basis for systematic mapping of channels and bars, as well as broadscale land-cover and vegetation characteristics. Geomorphic features were mapped for each of the seven photography sets and from the LIDAR. The mapped features form a foundation for evaluating changes to channel and bar planform and support the analysis of depositional and erosional volumes described later in this report. Land cover and vegetation was mapped for only the photographs from 1939, 1962, 1965, and 2005 in order determine coarse patterns of change in vegetation cover and density within the geologic floodplain.

Mapping of geomorphic features was confined to the active channel, defined as the area typically inundated during annual high flows as judged by the presence of water and flow-modified surfaces (Church, 1988). Features within the active channel were divided into mapping units: (1) primary (low flow) channel, (2) gravel bars, (3) alcoves (side channels or other wetted areas connected to the primary channel), (4) tributaries, (5) jetties, (6) disconnected water features, and (7) the constructed boat basin. For each time period, all such features larger than about 200 m^2 were digitized at a scale of 1:1,000. All linework was reviewed at a scale of 1:3,000 by another project team member to ensure consistency between time periods.

The primary channel was mapped by digitizing the wetted perimeter of the main channel as shown on aerial photographs and the LIDAR topography. Gravel bars, defined as gravel-covered surfaces with evidence of recent mobilization (bare or sparse vegetation) were separated into two categories: floodplain bars (sharing a margin with the floodplain) and island bars (completely surrounded by water). Tributary channels and tributary fans were also mapped where these features were discernable; however, due to differences in photograph resolution and vegetation, tributary features present in certain time periods were not always apparent in others. Disconnected water features were defined as any water body within the active channel area completely separated from other water features, and mostly consisted of ponds in swales on floodplain bars. Constructed features consisted of the boat basin, jetties, and the dike alongside the boat basin.

Although geomorphic features were mapped for only the active channel corridor, basic land-cover attributes, including vegetation, were mapped for the entire geomorphic floodplain, but for only four time periods. The geomorphic floodplain was defined for this study as the relatively flat surface formed of recent alluvium occupying the valley bottom, and was mapped on the basis of topography and field inspection. The floodplain boundaries depicted here do not necessarily correspond to inundation levels of specific flood discharges or flood frequency. Choices of map units for the land cover and vegetation mapping were based on review of historical and recent aerial photographs to ensure that each of the land cover classes could be distinguished from each set of photographs, supplemented by field inspections during September 2008. Species information was compiled from field manuals and with assistance from silviculturist Robyn Darbyshire (U.S. Department of Agriculture Forest Service, oral commun., September 12, 2008).

Eight mappable classes of land cover were defined, with three of these classes also assigned vegetation density ranges. Detailed descriptions of each mapping category are provided in the metadata accompanying the GIS files (U.S. Geological Survey, 2009) and are only summarized here: All wetted features, including the primary channel and alcoves, are mapped as *Water*, whereas rocky outcrops, including “Tide Rock” and “Morris Rock” (fig. 1), are mapped as *Bedrock*. Major paved roads, as well as developments and clusters of houses are mapped as *Developed* areas, though individual houses and small dirt roads are classified according to the surrounding land cover. *Bare* surfaces are nonbedrock terrestrial surfaces with less than 25 percent cover of discernable vegetation, typically appearing very light colored on aerial photographs. These are chiefly gravel bars with recently disturbed surfaces (fig. 8). *Sparse Vegetation* is the designation for surfaces with 5–25 percent vegetative cover, and typically consists of isolated trees, grasses, and shrubs. These areas are also almost always gravel bars vegetated with early successional species (fig. 8). Grasses, lawns, agricultural lands, and various herbaceous communities (including *Vetch* spp., *Bacharis* spp., and members of the composite family) are mapped as *Herbaceous Vegetation*, which has smooth texture and light brown or gray color in the aerial photographs (fig. 8). The *Woody Shrub* mapping unit is for areas with low canopies (chiefly less than 5 m) sufficiently dense to appear relatively smooth in the aerial photographs. Woody shrub cover is typically composed of willows (*Salix* spp.) and small (less than 5 m tall) alders (*Alnus* spp.). This type is found almost exclusively on gravel bars, commonly growing in narrow groves or thickets aligned parallel to the channel (fig. 8). Clusters of large trees are mapped as *Mature Trees*, and typically included black cottonwood (*Populous balsamifera*), myrtlewood *(Umbellularia californica)*, and tall alders on floodplain surfaces outside of the active channel area (fig. 8). Although mature trees typically had a distinct size and texture when compared against willows and other shrub-type vegetation in the aerial photographs, it was difficult to discern small trees from willows; hence, canopies associated with trees less than about 5 m tall were grouped together in the *Woody Shrub* category. Vegetation density values of moderate (25–75 percent cover) and dense (75–100 percent cover) were assigned to *Herbaceous*, *Woody Shrub*, and *Mature Tree* mapping units.

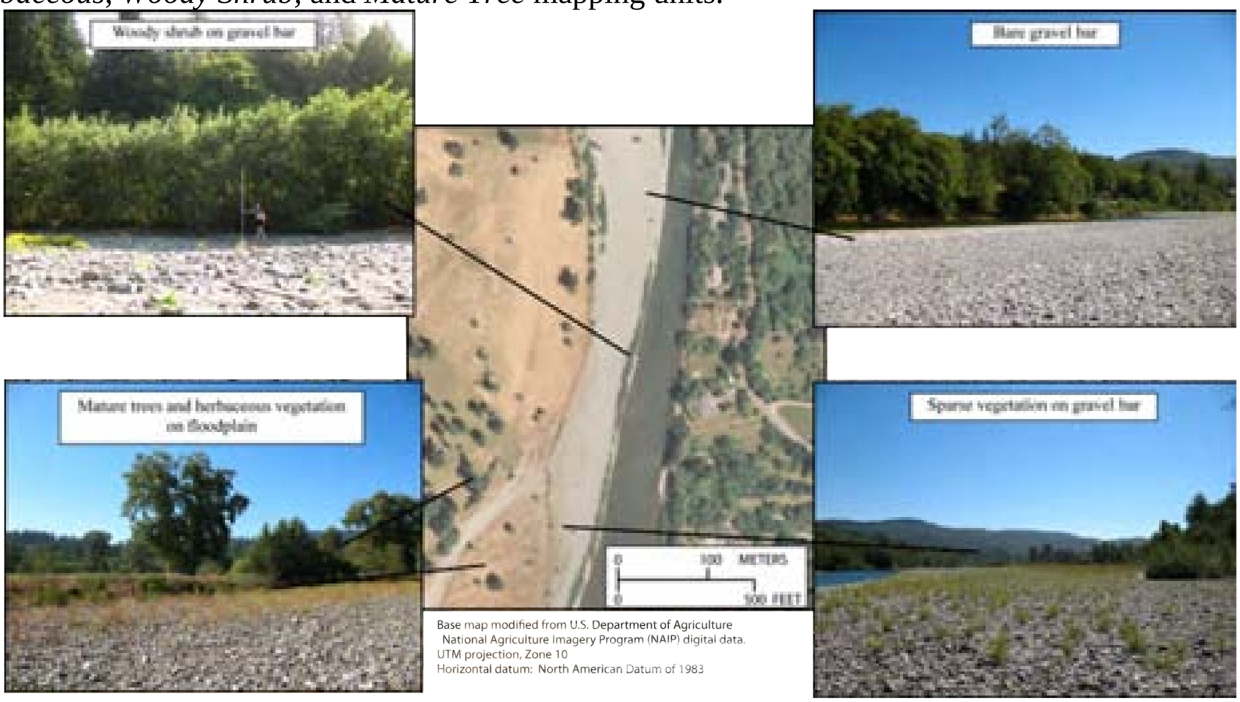


Figure 8. Photographs showing examples of landcover mapping categories, as depicted in an orthophotograph from 2005 and oblique photographs near floodplain kilometer 9 of the Chetco River, Oregon. Land cover was mapped from aerial photographs and included five vegetation categories: *Bare, Sparse Vegetation, Herbaceous Vegetation, Woody Shrub,* and *Mature Trees*. (Photographs by Scott Anderson, U.S. Geological Survey, September, 2008.)

The bank materials along the Chetco River corridor were mapped in such a manner as to differentiate reaches bordered by erodible sediments from reaches flanked by more resistant bedrock or artificial revetment. Bank materials were defined as the natural or artificial material bordering the active channel and were mapped by walking the length of the study area and recording the condition and composition of the channel banks. Field observations were then compared with the recent orthoimagery and LIDAR topography to construct continuous maps of bank materials along both edges of the active channel at a scale of 1:5,000. The map units include the primary types of bank materials: (1) floodplain risers formed of erodible sand and gravel contained in fluvial deposits flanking the active channel, (2) bedrock outcrops, and (3) artificial fill (primarily consisting of material used to fill the former tidelands near the present location of the boat basin at FPkm 0). Bank protection revetment, chiefly consisting of large angular boulders, was mapped as an overlay to the three primary categories of bank material.

Results of Channel Mapping

Evident overall trends for 1939-2008 for active-channel features of the study reach are a 34 percent reduction in gravel bar area and a slight decrease in channel sinuosity (fig. 9). Channel width has not changed systematically over this time period. The reduction in bar area is much greater than can be attributed to differences in flow stage between photo sets (figs. 9 and 10). These overall changes, however, reflect a temporally and spatially varied history of channel behavior. The largest change, the decrease in bar area, is almost entirely accounted by the large reduction in floodplain bar surfaces between 1965 and 1995. Prior to 1965 and subsequent to 1995, bar areas may have increased slightly for some reaches, especially between 2005 and 2008, although at rates small relative to uncertainties mapping and the effects of the different discharges on mapped areas (figs. 9 and 10).

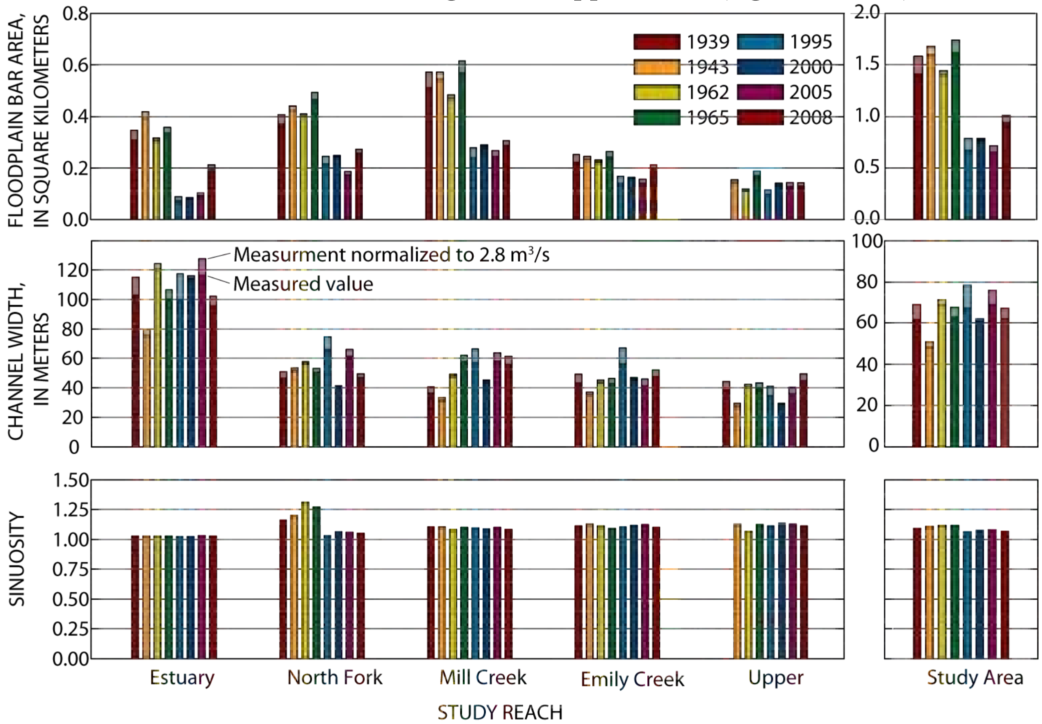


Figure 9. Graphs showing summary of channel change during 1939–2008 for Chetco River, Oregon, study area. The 1939 photographs only partly cover the Upper Reach; hence there are no 1939 measurements for bar area and sinuosity for that reach, and channel width is only a partial measurement.

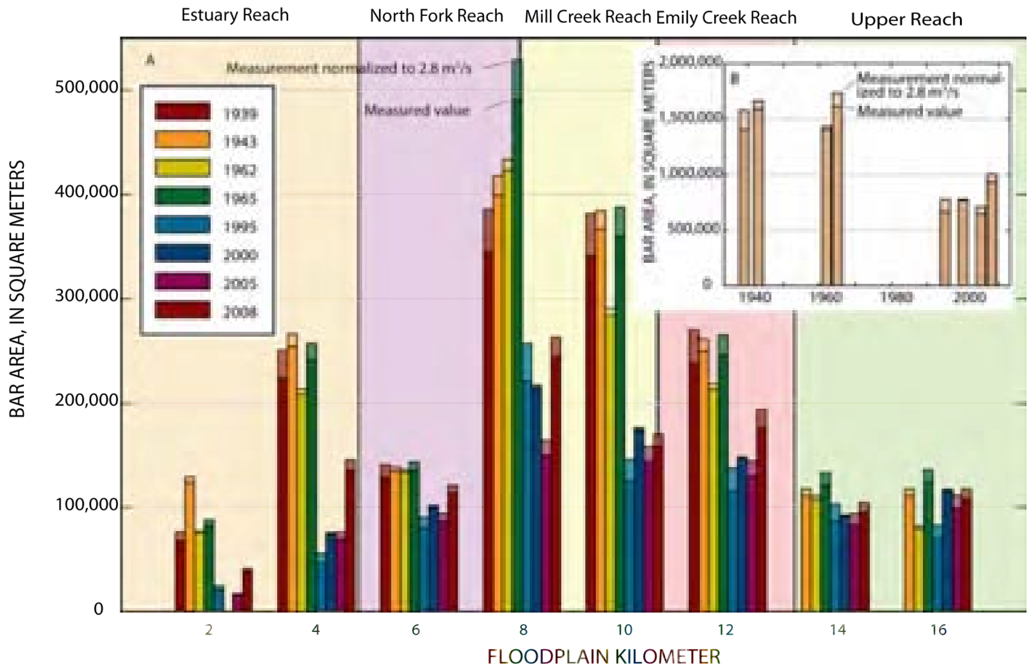


Figure 10. Graph showing spatial and temporal variation in gravel bar area for eight locations along the Chetco River, Oregon, 1939-2008. A. Aggregated by 2-kilometer-long lengths of floodplain. No data for 1939 upstream from floodplain kilometer 13. B. For total study reach.

Historical channel change for 1939–2008 along the Chetco River was greatest along the lower reaches where the valley bottom is wide and a greater percentage of the channel is bordered by more erodible floodplain materials (figs. 11–15). The North Fork (fig. 13) and lower Mill Creek (fig. 14) Reaches have had the most planform change. For the North Fork Reach, the 1939 channel was relatively sinuous and narrow, with a sinuosity of 1.16 and an average width of 47 m. The maps from 1995 to 2008 show the channel to be straighter, with a sinuosity in 2008 of 1.05. In conjunction with sinuosity changes, the average water-surface slope of the North Fork Reach has increased by about 10 percent between 1939 and 2008, from 0.000767 m/m to 0.000849 m/m. Low-flow channel width changes have been more variable; for example, reach average width along the North Fork Reach was 66 m in 1995, 41 m in 2000, 61 m in 2005, and had decreased to 47 m by 2008 (fig. 9). Between 1939 and 2008, normalized (for flow stage) total bar area for the North Fork Reach diminished from 400,000 m^2 to 270,000 m^2 (fig. 9). Similarly, bar area for the Mill Creek Reach has been reduced from 600,000 m^2 in 1939 to about 300,000 m^2 in 2008 (fig. 9). The net changes for these reaches, however, do not reflect continuous trends as there have been episodes of increases in sinuosity and bar area within the overall record (figs. 9 and 10).

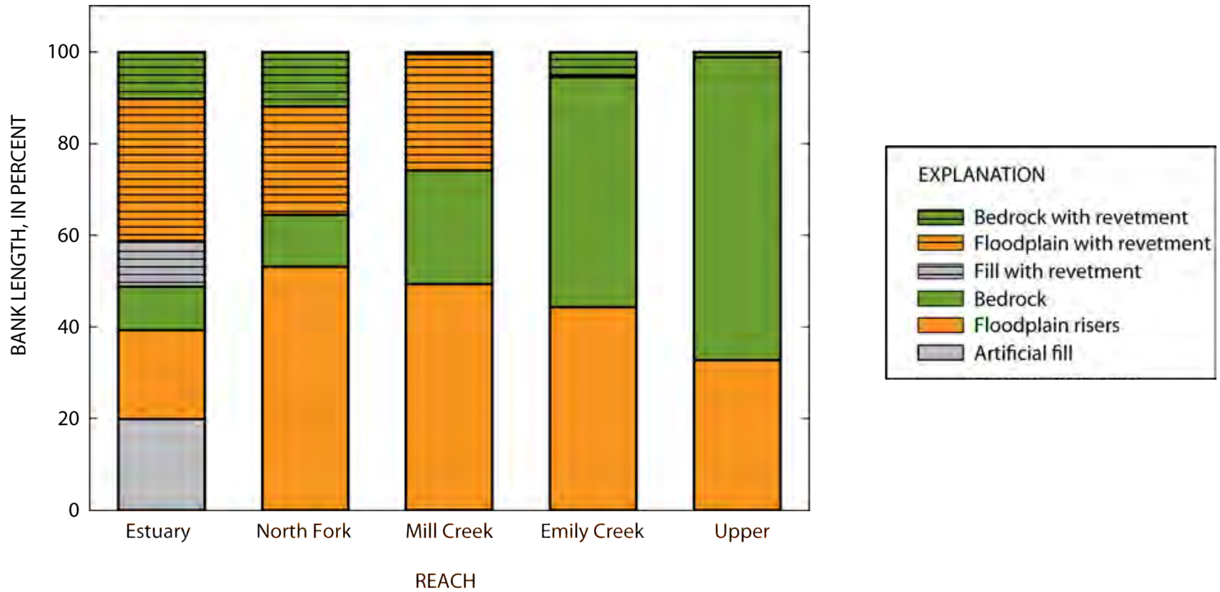
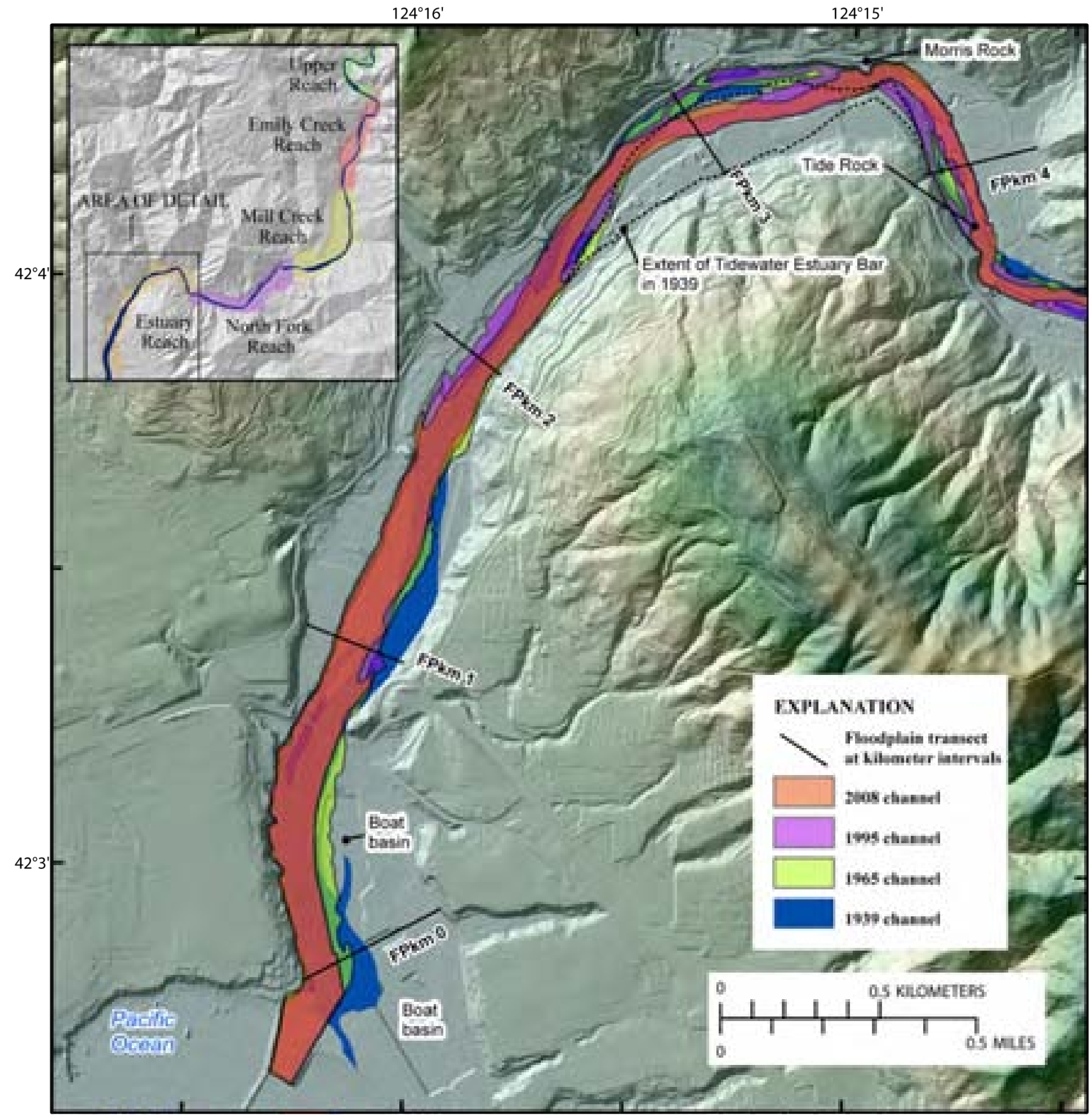


Figure 11. Graph showing reach segregated distribution of bank material and revetment between floodplain kilometer 0 and 16, Chetco River, Oregon.



Base map modified from Oregon LIDAR Consortium digital data.
UTM projection, Zone 10
Horizontal datum: North American Datum of 1983

Figure 12. Map showing channel changes between floodplain kilometer 0 and 4.5, encompassing the Estuary Reach, Chetco River, Oregon, 1939–2008. FPkm, floodplain kilometer.

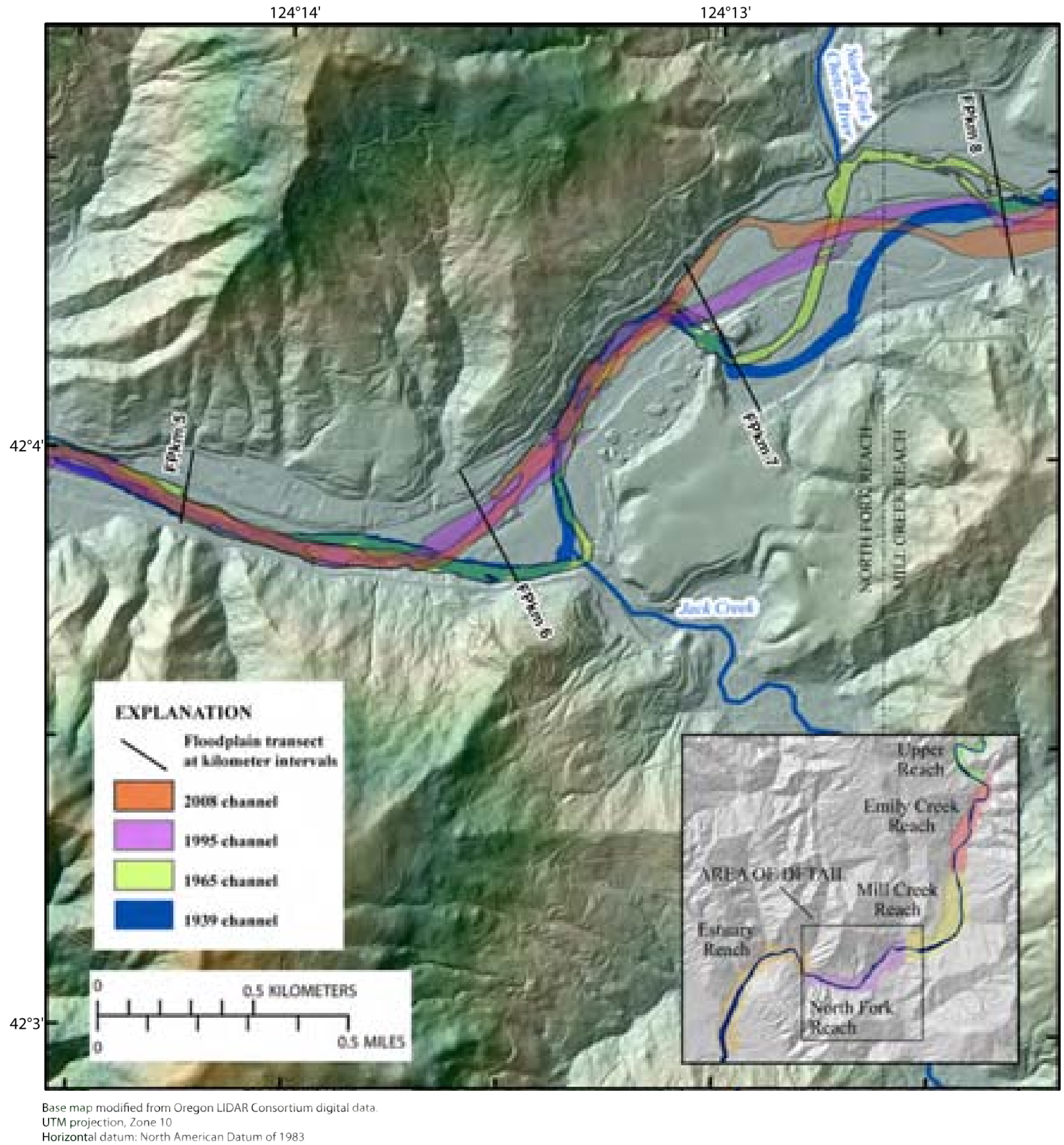


Figure 13. Map showing channel changes between floodplain kilometer 4.5 and 8.4 encompassing the North Fork Reach, Chetco River, Oregon, 1939–2008. FPkm, floodplain kilometer.

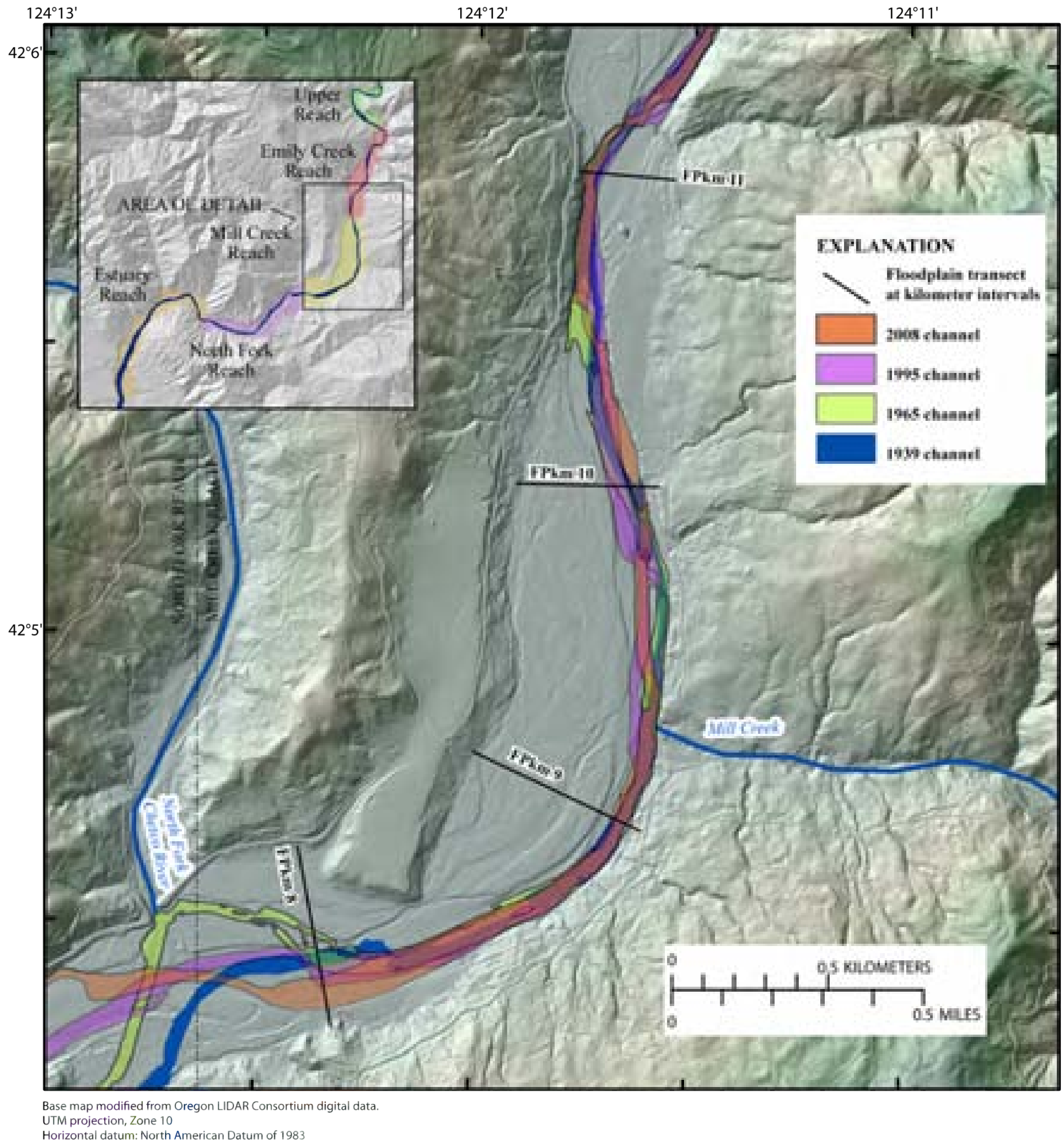


Figure 14. Map showing channel changes between floodplain kilometer 7.5 and 11.5 encompassing the Mill Creek Reach, Chetco River, Oregon, 1939–2008. FPkm, floodplain kilometer.

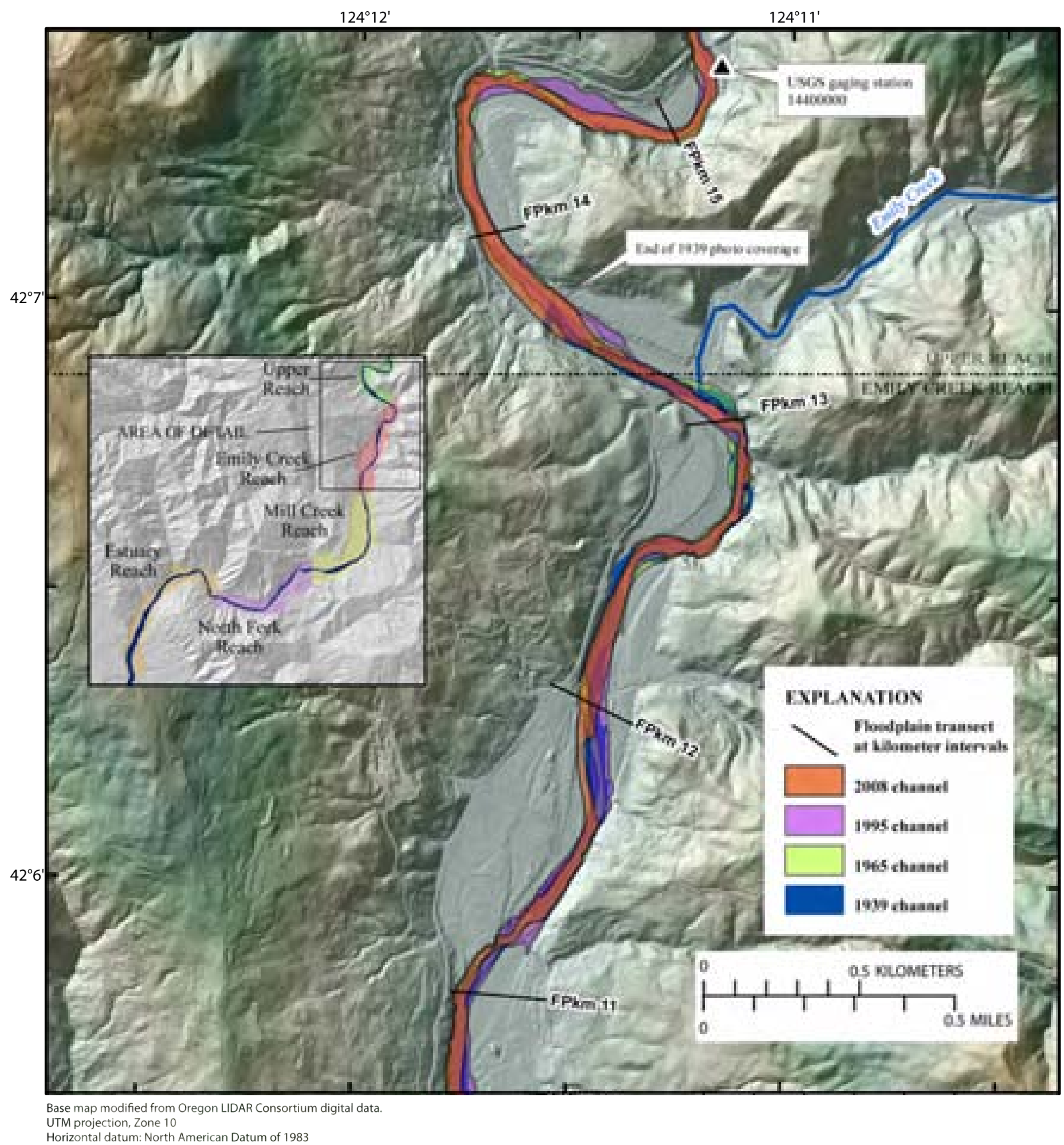


Figure 15. Map showing channel changes between floodplain kilometer 10.6 and floodplain kilometer 15.2 of the Chetco River, Oregon, along the Upper and Emily Creek Reaches, 1939–2008. 1939 coverage extends only to floodplain kilometer 13.7. FPkm, floodplain kilometer.

Inspection of the individual photography sets show that the changes along the North Fork Reach took place in several steps. During 1943–1962, channel migration at rates of up to 14 m/yr between photography sets created a large meander bend near the confluence of the North Fork Chetco River (FPkm 7.5). During winter 1969–70, a large bend near the confluence of Jack Creek[1] (FPkm 6) was cut off and abandoned (probably during the January 1970 flood of nearly 1,900 m^3/s. Between 1969 and 1976, two similar avulsions resulted in abandonment of the North Fork bend (FPkm 7.5) and a smaller bend near FPkm 6[2]. It is likely that the two avulsions at FPkm 6 and 7.5 were during the 1970–72 period of large floods with peak discharges of 1,300–1,900 m^3/s (fig. 2). These avulsions in the late 1960s and early 1970s account for the major decrease in sinuosity for the North Fork Reach between 1965 and 1995 (fig. 9). Partly as a consequence of these channel changes, bank revetment has been placed along these channel margins in the North Fork Reach, so that revetment and bedrock now border 47 percent of the reach in contrast to more than 75 percent of the North Fork Reach being historically bordered by erodible alluvial floodplain materials (fig. 11). In recent decades, the lower Mill Creek Reach and North Fork Reach have been much less dynamic than for the period 1939–1965, shifting laterally at rates less than 6 m/yr and with no significant avulsions (figs. 13 and 14).

Along the Estuary Reach, the overall style of planform change from 1939 to 2008 has been lateral shifting of the channel between the confining valley walls, in conjunction with substantial loss of net bar area (figs. 9, 10, and 12). For example, near FPkm 3, channel maps from 1939 to 1965 show the low flow channel against bedrock along right bank, and a large (150,000 m^2) gravel bar (known locally as “Tidewater Estuary Bar”) along the left bank. Between 1965 and 1989,[3] the channel shifted south to erode much of this bar (fig. 12). Additionally, higher elevation areas of Tidewater Estuary Bar, which appear bare and recently active in the photographs from 1939 to 1965, were protected by revetment and developed for residential and commercial use by 1989. The cumulative result of these types of changes is that bar area for the Estuary Reach has decreased 36 percent between 1939 and 2008, although bar area has recently increased between 2005 and 2008 (figs. 9 and 10). Development along the Estuary Reach has resulted in extensive bank stabilization; 41 percent of the channel margin is now bordered by revetment (fig. 11).

Significant changes to the mouth of the Chetco River are the result of 20th century development and navigational improvements that began in the 1950s. The aerial photography from 1939 and 1943 depict the mouth of the Chetco River as approximately 200 m wide, with extensive sand bars and tidal lagoon. By 1962, a pair of jetties restricted channel width and closed off the former lagoon. By 1995, continued bank protection, jetty extension and filling of former lagoon areas resulted in an overall straightening and narrowing of the channel so that channel width at the mouth presently ranges from 100 to 120 m; about half the width shown on the earliest maps and photos (fig. 13).

Channel change along the middle and upper reaches of the study area has been much less than for the lower Mill Creek, North Fork and Estuary Reaches. Within the Emily Creek and Upper Reaches, as well as the upper part of the Mill Creek Reach, the channel crosses back and forth between the valley walls, with intervening channel-flanking gravel bars. The general pattern and positions have remained generally stable, with the most stable locations being where the channel abuts the bedrock valley walls (figs. 14 and 15). In isolated locations, the river has migrated laterally at rates up to 6 m/yr where crossing from valley side to side. Where the valley bottom widens towards the lower portion of the Mill Creek Reach (FPkm 7.5-8.5), the channel has been more active, particularly in the period from 1943 to

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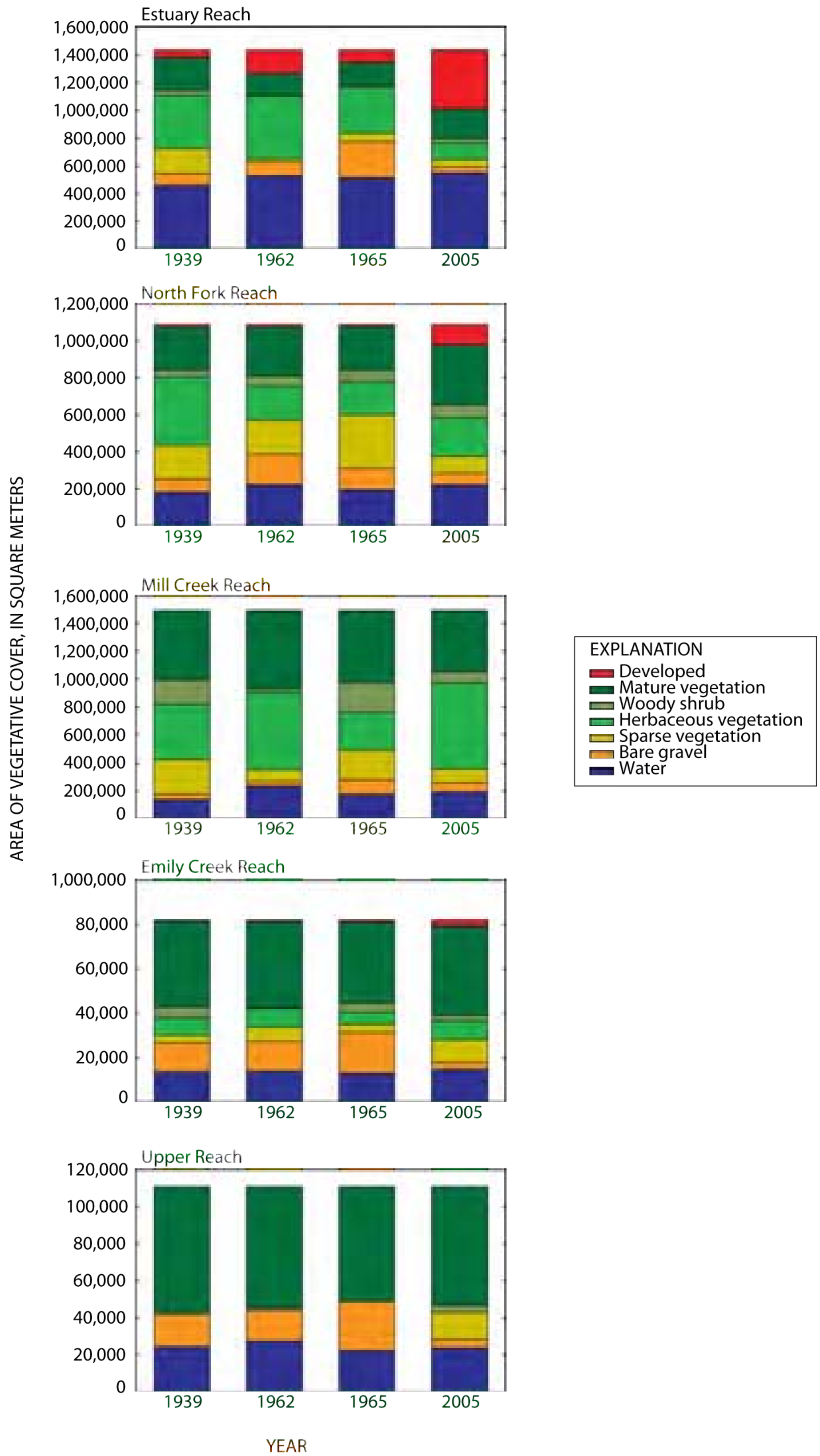
[1] Timing of avulsion is based on inspection of un-rectified aerial photographs provided by the Bureau of Land Management.
[2] Timing of these avulsions is based on inspection of photographs from 1969 provided by the Bureau of Land Management and aerial photography from 1976 used as base map in the Flood Hazard study for the Chetco River (Soil Conservation Service, 1979).
[3] Timing of channel change is based on aerial photographs from 1965 (this study) and unrectified aerial photography provided by the Bureau of Land Management.

1962 when rapid migration resulted in the formation of a large meander bend near the North Fork confluence (fig. 14).

Results of Land Cover Mapping

The land cover and vegetation mapping shows that the dominant land cover for the geomorphic floodplain is *Mature Trees*, covering about 30 percent of the floodplain in 2005 and primarily consisting of floodplain forests outside of the active channel (fig. 16). In total, *Water* occupies about 20 percent of the floodplain at low flow. *Developed* area accounts for about 30 percent of the floodplain area along the Estuary Reach in 2005. The *Mature Trees* category systematically decreases as a percentage of floodplain area downstream, as does *Water* except for the North Fork and Estuary Reaches. *Developed* area is only significant in the North Fork and Estuary Reaches, and primarily for the 1962 and more recent photographs. The most dynamic classes are the *Bare*, and the *Sparse*, *Herbaceous*, and *Woody Shrub* vegetation categories, which cover the greatest relative area in the Mill Creek and North Fork Reaches. These cover-type vegetation classes are chiefly associated with gravel bars subject to colonizing vegetation. No obvious trends are evident for these classes except that the combined area of *Water*, *Bare*, and *Sparse* vegetation was greatest for all four reaches in 1965, mostly at the expense of *Woody Shrub* and *Mature Trees* categories, likely indicating floodplain erosion and vegetation removal by the flood in 1964.



Estuary Reach
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1939
1962
1965
2005
North Fork Reach
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Mill Creek Reach
Emily Creek Reach
1,000,000
80,000
60,000
40,000
20,000
Upper Reach
120,000
100,000
AREA OF VEGETATIVE COVER, IN SQUARE METERS
YEAR
EXPLANATION
Developed
Mature vegetation
Woody shrub
Herbaceous vegetation
Sparse vegetation
Bare gravel
Water

Figure 16. Graphs showing changes in floodplain landcover by analysis reach, Chetco River, Oregon, 1939–2005. Upper Reach data includes only the 0.5 km length of floodplain covered by the aerial photographs from 1939.

Vertical Changes in Channel Morphology and Bathymetry

Although lateral channel changes may have significant resource, habitat, and hazard consequences, changes in the vertical position of the bed are more indicative of riverwide changes in the balance between sediment input and export (Schmidt and Wilcock, 2008). Vertical changes are also more difficult to detect without systematic surveys of the channel. For this study we have compared two previous lengthy surveys—a U.S. Army Corps of Engineers navigational survey in 1939 for the Estuary Reach between FPkm 0 and 4.5, and a 1977 survey for a Soil Conservation Service (1979) flood study of the upstream reaches between FPkm 4 and 15—with the LIDAR topography acquired in 2008 and our own surveys during summer 2008 made as part of this study. Additional local bed elevation information comes from repeat surveys of isolated cross sections in the fluvial reaches as well as the detailed information on channel bed changes from streamflow measurements at the USGS gaging station at FPkm 15.24.

Survey data used in study

Of several early surveys near the mouth of the Chetco River (table 3), the most useful survey for characterizing channel morphology along the Estuary Reach is the navigational survey of 1939 (U.S. Army Corps of Engineers, 1939), in which closely spaced soundings and elevations in feet relative to Mean Lower Low Water (MLLW) are provided for FPkm 0 to 4.5. Details of digitizing, georeferencing, and datum conversion are included in the metadata for the accompanying GIS maps (U.S. Geological Survey, 2009), but in summary, this survey included more than 1,000 points over the lowermost 4.5 km of channel. The survey from 1939 was compared to a USGS bathymetric survey in September and October 2008 between FPkm 0 and 3. This boat-based survey used a depth-sounding transducer mounted directly below a real-time kinematic (RTK) global positioning system (GPS) receiver. As the survey boat traversed the estuary at transects spaced at 30 to 50 m intervals, the depth-sounder recorded water depth while the GPS recorded the boat position and GPS ellipsoid height for a total of nearly 200,000 points (complete metadata and GIS layers available in U.S. Geological Survey, 2009).

The bathymetric data of 1939 and 2008 for the Chetco River estuary were interpolated to three-dimensional surfaces using a modified version of the procedure of Merwade and others (2005), which entails transforming the data into a channel oriented coordinate system, interpolating a continuous surface using anisotropic kriging, and reprojecting the surface back to the project coordinate system of UTM NAD83 (fig. 17). Once the bathymetric surfaces were created, longitudinal profiles of the channel thalweg from each time period were extracted and plotted against river kilometers for 2008.

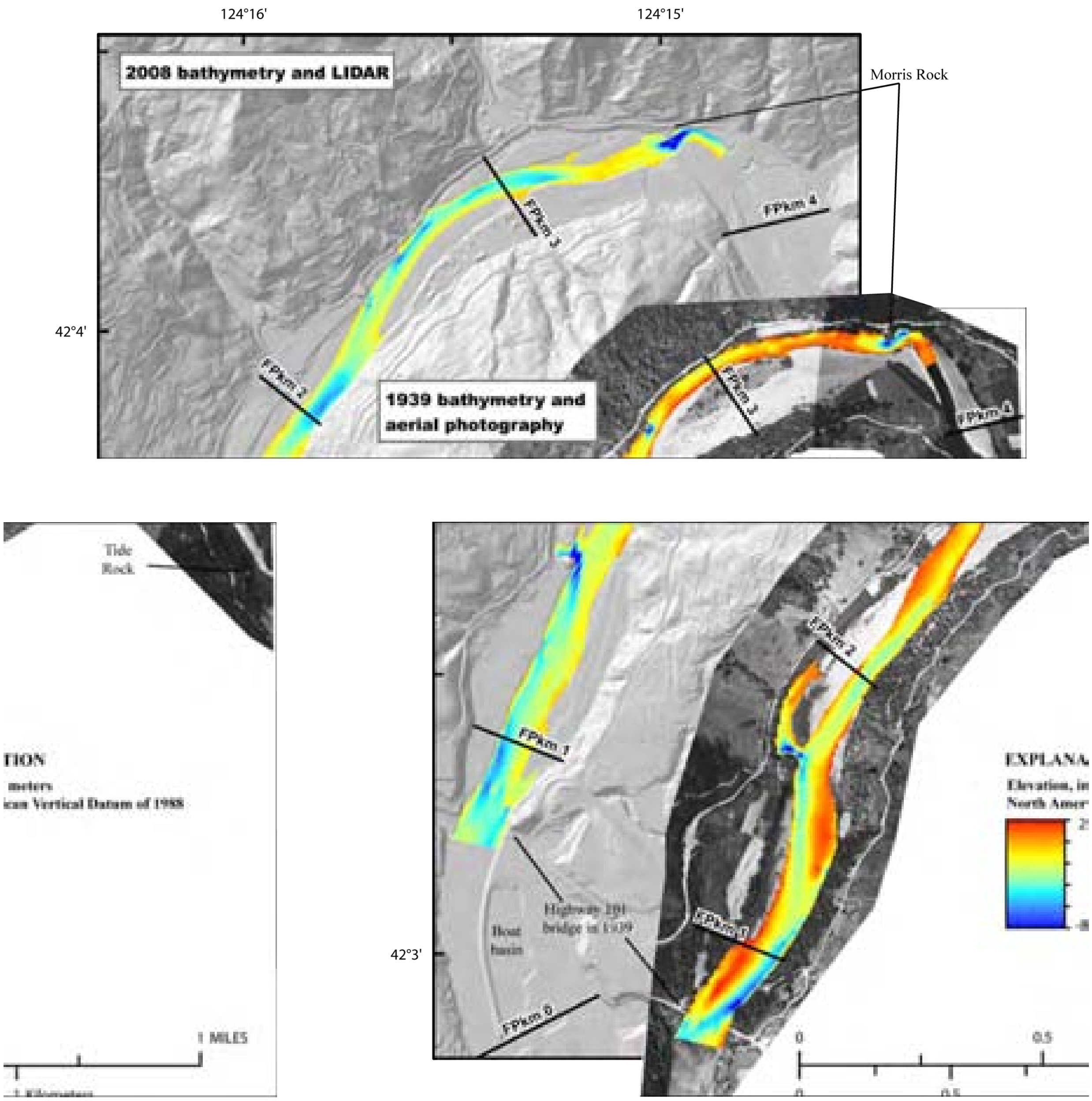


Figure 17. Map showing bathymetry for 1939 and 2008 between floodplain kilometer 0.6 and 3.7, Chetco River, Oregon. Bathymetry from 1939 derived from U.S. Army Corps of Engineers (1939); bathymetry for 2008 from this study. Map and survey processing described in metadata for the supporting GIS files is, available from the USGS (U.S. Geological Survey, 2009, at http://or.water.usgs.gov/chetco/.)

To determine vertical channel changes along the upstream fluvial reaches of the study area between FPkm 4 and 15, longitudinal profiles and cross sections were compiled from a 1977 survey and compared to 2008 elevation data and surveys. In 1977, 42 cross sections across the entire valley bottom between FPkm 0 and 15.5 were surveyed as part of a flood hazard study by the Soil Conservation Service (1979). The location of each survey transect was depicted on orthophotographs from 1976, and cross-section data shown by plots of distance (in feet from an arbitrary point) against elevation (in feet referenced to NGVD 29 datum). From this information, cross section locations and data were digitized by visually plotting survey transects shown in the orthophotos from 1976 onto the orthophotos from 2005. The elevations for 1977 were shifted from NGVD 29 datum to the NAVD 88 datum using the CorpsCon conversion routine (*http://crunch.tec.army.mil/software/corpscon/corpscon.html*, accessed January, 13, 2009) and by comparing elevations of benchmarks surveyed in 1977 and 2008 throughout the study area.

We approximately matched nine of these cross sections from 1977 by (1) using October 2008 RTK GPS and depth-sounder surveys of the active channel at the estimated locations of the cross sections from 1977, (2) merging these October 2008 channel surveys with the LIDAR from May–June 2008 to extend the surveys for 2008 across the valley bottom, and (3), where required, shifting the cross section data from 1977 laterally so that obvious and stable topographic features such as road beds and steep banks were aligned with those on the cross sections for 2008. Such adjustments were necessary in a few cases as a consequence of not being able to precisely locate the cross section locations for 1977. The survey in 2008 also produced a nearly complete longitudinal profile of the channel thalweg from FPkm 4 to 15 (fig. 4), which can be compared to the minimum elevation for each of the 42 cross sections surveyed in 1977. These surveys were supplemented by ancillary survey data for 1980–82 reported by Klingeman (1993; fig. 18).

The final source of vertical change information is from analysis of the history of stage-discharge rating curves at the USGS streamflow measurement station at FPkm 15.2. Following the approach of Klingeman (1973) and Smelser and Schmidt (1998), we conducted a specific gage analysis for the available record from October 1, 1969, to May 1, 2009. The specific gage analysis allows detection of changes in streambed elevation by assessing changes in water elevation (stage) through time for a set of discharge values. At USGS streamflow-gaging stations, discharge is related to stage by a stage-discharge rating curve, which is based on multiple simultaneous measurements of stage and discharge. If channel conditions change substantially (as evidenced by consistent offsets of newer measurements from established rating curves), or if a station is moved, a new rating curve will be developed. The specific gage analysis evaluates trends in bed elevation as indicated by the sequence of rating curves. For situations where channel width and roughness remain stable, the sequence of stages for a given discharge directly relates to changes in bed elevation. For the Chetco River, the analysis is straightforward because there have been no relocations or datum shifts for the station, although the record is shorter than for many USGS streamflow measurement stations and 3 of the 39 ratings were unavailable.

Uncertainty and Limitations Associated with the Repeat Survey Data

The total uncertainty regarding the resulting bathymetric surfaces created from the survey data of 1939 and 2008 is a function of the original data and the processing involved with creating digital maps and interpolated surfaces of the bathymetries. Although the accuracy of the original map from 1939 is unknown, the process by which the original map was registered, rectified, and digitized may have introduced uncertainty on the order of ± 20 m for the horizontal positioning of points, but in most locations is substantially less. The interpolation procedure introduces additional error and uncertainty, thus the total accuracy of the bathymetry for 1939 is estimated to be ±20 m for horizontal and 1 m in the vertical dimension as determined from distribution of differences between the digitized survey points and the gridded elevation data. Each of the points from the bathymetric survey in 2008 has a horizontal accuracy of ±0.015 m and a vertical accuracy of approximately ±0.05 m. The interpolated bathymetric surface in 2008 is generally within ±0.3 m of the original survey elevations.

The survey in 1977 by the Soil Conservation Service (1979) was in support of a flood hazard study and preparation of flood hazard maps. The survey is described (Soil Conservation Service, 1979, p. E-1) as a "third order field survey" using USGS base elevations. For such surveys, elevation tolerances (RMSE) are typically less than 0.15 m (American Society of Civil Engineers, 1999, p. 6). The conversion of the original sea level (NGVD 29) datum to NAVD 88 is straightforward and the converted data match resurveys in 2008 of benchmarks used in the 1977 to within 0.05 m. Therefore, the primary source of uncertainty regarding the survey in 1977 is its horizontal positioning. The only available information for the precise location of the measurements for 1977 is the 1:4,800 photomosaic maps in the Soil Conservation Service (1979) report. On the basis of these maps, the cross section locations for 1977 were digitized onto the photomosaic for 2005 used for this analysis by reference to stable features visible on both photography sets. We judge the uncertainty associated with the horizontal placement of the cross sections from 1977 on the maps for 2005 to be everywhere less than 150 m. Such an offset in conjunction with the 0.001 average slope of the study reach would introduce vertical errors of less than 0.15 m attributable to uncertainty in horizontal cross section position for thalweg and water-surface elevations (assuming uniform slope and depth). The accuracy of the cross-section data surveyed in 2008 as a part of this study is approximately ±0.015 m, whereas vertical accuracy is approximately ±0.05 m. Discrepancies between the cross-section alignments in 1977 and 2008 cause some cross sections of 1977 to portray slightly different areas of the bar and floodplain than are depicted in the matching cross section of 2008; therefore, the cross sections are best viewed in terms of overall trends, especially for thalweg elevations, as differences in bank geometry do not necessarily indicate channel shifting.

Results of Repeat Surveys

Comparison of bathymetric surfaces within the Estuary Reach from 1939 and 2008 shows that the bed of the Chetco River was generally lower in 2008 than in 1939 (fig. 17). A difference calculation for the bathymetric surfaces for 1939 and 2008 between FPkm 0.5 and 3.5, corresponding to the reach between the Highway 101 Bridge to Morris Rock, indicates a net loss of 150,000 m^3 of channel substrate between 1939 and 2008. This corresponds to an average lowering of the entire channel bottom by about 0.5 m. Locally, however, there are three primary locations where channel shifting has resulted in much greater magnitudes of incision and aggradation (fig. 17). Near FPkm 3, the channel historically flowed against the right bank with bottom elevations of approximately 0.5 m (NAVD 88). By 2008, the channel had shifted towards the left bank and had deepened by 0.2 to 2.0 m, with the bed elevations in 2008 ranging from 0.3 to -1.5 m (NAVD 88). Near FPkm 1.7 a large alcove in 1939 extended nearly 0.5 km from the right bank. By 2008, this alcove had aggraded by approximately 1 m, and the main arm of the alcove is presently filled with sediments and partially vegetated. Near FPkm 1.0 and just upstream of the Hwy 101 Bridge, the channel in 1939 flowed against the left valley wall, carving a deep channel with bed elevations ranging from –1.5 to –4 m (NAVD 88). By 2008, the channel had shifted to the right bank, and the thalweg from 1939 is presently an alcove with bed elevations of about –0.6 m. The thalweg of 2008 in this area is shallower (bed elevations of –1.5 to –2.5 m NAVD 88) and lacks the deep pool depicted in the survey from 1939.

For the short reach between FPkm 1.5 and 4.3, where all three surveys overlap, the longitudinal profiles from 1939, 1977, and 2008 indicate net lowering of the channel thalweg between 1939 and 2008 (fig. 18A). The magnitude of lowering is as great as 2 m, with the reach above FPkm 2 showing the most consistent bed lowering. The resolution of the survey in 1977 is not sufficient to clearly indicate whether the majority of the channel incision in the estuary was before or after 1977, but the survey in 1977 does show that the channel had at least locally aggraded by nearly 1 m near the Highway 101 bridge at FPkm 0.85 between 1939 and 1977 before incising back to its elevation of 1939 by 2008.

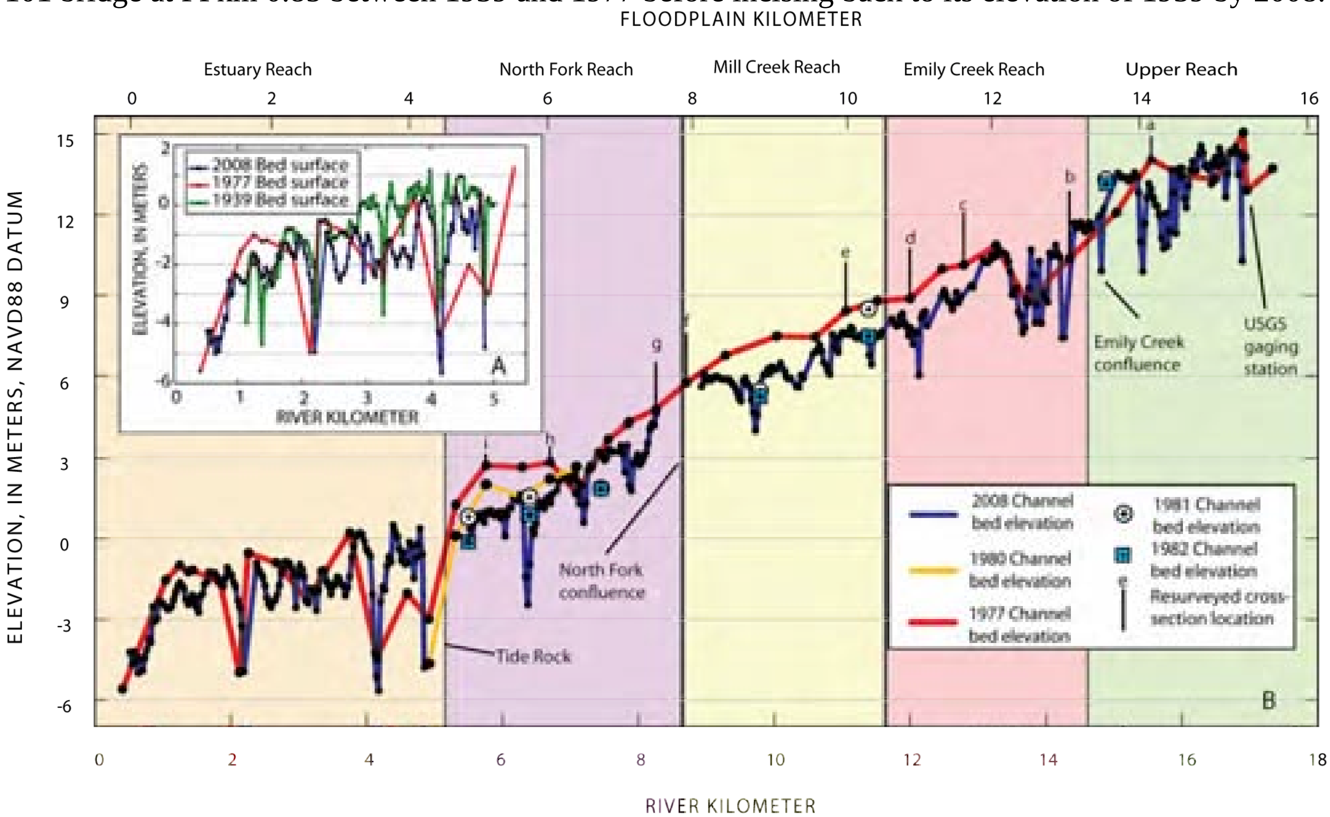


Figure 18. Graph showing channel thalweg profiles below river kilometer 18, Chetco River, Oregon. A. Channel thalweg profiles for Estuary Reach from bathymetric survey of 1939 (U.S. Army Corps of Engineers, 1939), cross sections from 1977 flood study survey (Soil Conservation Service, 1979), and USGS bathymetric survey in 2008. B. Channel thalweg profiles from bathymetric survey in 1939 (U.S. Army Corps of Engineers, 1939), flood study survey in 1977 (Soil Conservation Service, 1979), and USGS channel survey in 2008. Thalweg elevations for surveys in 1980–82 are from Oregon Department of State Lands surveys, as reported by Klingeman (1993).

Upstream of the Estuary Reach and the extent of the bathymetric surveys, comparison of longitudinal profiles derived from surveys in 1977 and 2008 shows mainly bed lowering, especially between FPkm 4.5 and 6 in the North Fork Reach and between FPkm 8 and 12 in the Mill Creek and Emily Creek Reaches. In these locations, the channel is consistently 1–2 m lower in 2008 than it was in 1977 (fig. 18B). This apparent lowering exceeds plausible uncertainties owing to survey accuracy. For the Upper Reach upstream of FPkm 12, net changes in bed elevation between the surveys in 1977 and 2008 have been small. In the Estuary Reach, the difference between the surveys in 1977 and 2008 indicate possible thalweg aggradation for the kilometer downstream of Tide Rock, but here the resolution of the survey in 1977 is poor in comparison to the bathymetric surveys (fig. 18A) which show net incision of about 1 m between 1939 and 2008.

Sparser measurements from 1980, 1981, and 1982, which were surveyed in relation to the survey in 1977 (Klingeman, 1993), indicate that a substantial portion of the channel lowering in the Estuary, North Fork, and Mill Creek reaches was before 1982 at some locations (fig. 18A). Examination of the repeat surveys of the cross sections surveyed in 1977 and 2008 (fig. 19) indicate that channel lowering between FPkm 4 and FPkm 12 was independent of the rest of the active channel, as bar elevations appear similar in 1977 and 2008 (particularly for cross sections e, f, and g in fig. 19).

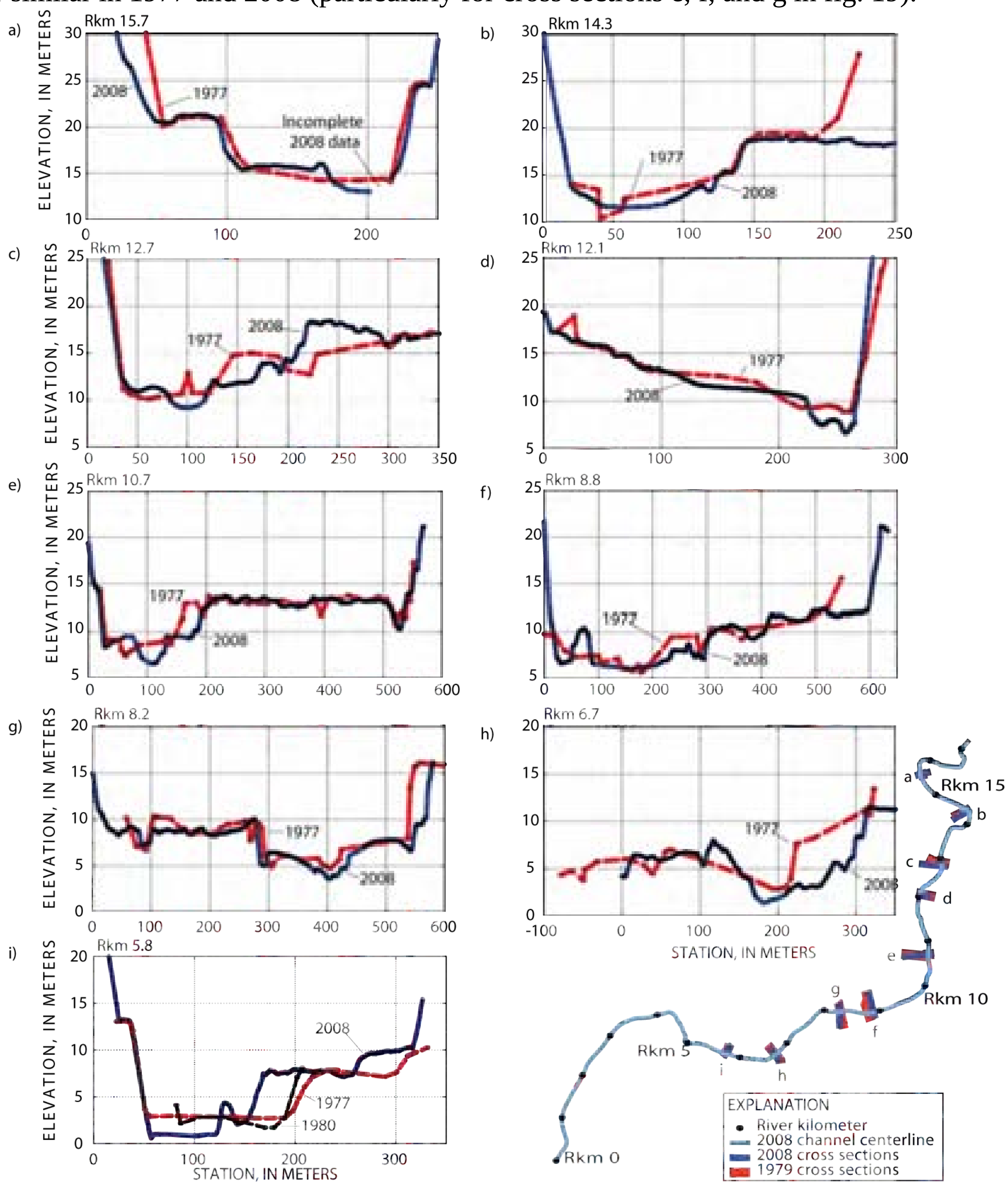


Figure 19. Graph showing comparison cross-sections from the flood study survey in 1977, digitized from Soil Conservation Service (1979) and approximately relocated during the USGS resurveys in September 2008, Chetco River, Oregon. Imperfect relocation results in discrepancies for some sections, but all are judged to be within 150 m of original location. Cross section locations also shown on figure 18B profile plots.

Information collected during the course of flow measurements at the USGS gaging station at FPkm 15.24 provides another source of quantitative information on channel change (fig. 20). The specific gage analysis (fig. 20A) encompasses 39 separate ratings over nearly 30 years. The large number of ratings is in itself indicative of frequent changes in local geometry and substantial bed-material transport. For comparison, the South Umpqua River near Brockway has had only 11 ratings since 1942 (O'Connor and others, 2009). The ratings for the lower discharges are sensitive to scour and fill of low-flow pools and riffles near the measurement section and consequently show more variation. For example, the rating for the 5.5 m^3/s flow shows an overall trend of bed lowering after a period of slightly higher stages in the late 1970s, consistent with the ratings for all discharges, but with a total variation of 1.2 m. The ratings for the larger flows reflect more general reach scale channel and floodplain conditions, including the volume of gravel in the bar flanking the left margin of the channel (fig. 20B), and indicate an overall lowering of flow-stage elevations since 1970, although with smaller magnitudes of change. But within the overall lowering trend, the high-flow ratings show evidence of aggradation and narrowing in the late 1970s as well in 1997, after the 2,169 m^3/s peak discharge in 1996. For all flow ratings, however, the overall trend has been a net decline of flow stage associated with specific discharges, ranging from 0.86 m for the low flows to 0.28 m for the higher analyzed discharges. The series of ratings, especially for the larger discharges, also indicate aggradation of approximately 0.2–0.3 m culminating between 1976 and 1978, followed by nearly continuous decline until an episode of aggradation in the late 1990s, interrupted by aggradation and narrowing after the 1996 flood. Since 2000, all ratings have declined between 0.2 and 0.4 m (fig. 20A).

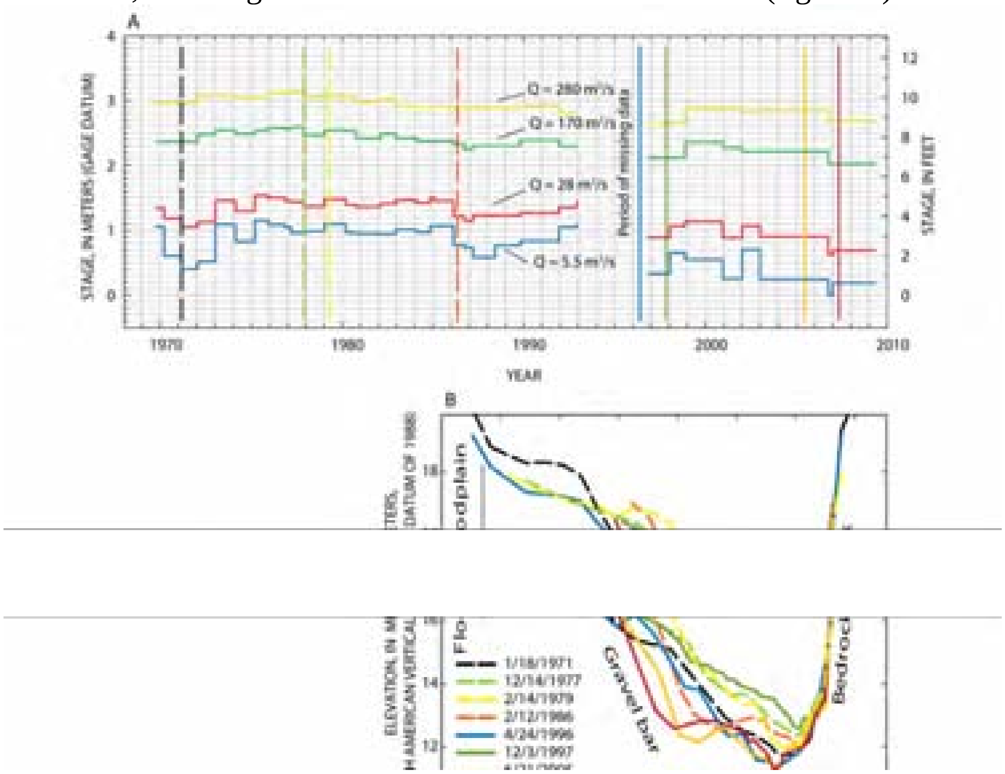


Figure 20. Graph showing specific gage analysis and flow-measurement cross sections for the USGS streamflow gage Chetco River near Brookings, OR (14400000). A. Specific gage analysis following approach of Klingeman (1973) and encompassing 39 ratings used between 1970 and 2008. Rating curves available at the Oregon Water Science Center in Portland, Oregon. Data for ratings 28–30 not available.

B. Selected cross sections extracted from flow measurements at station cableway. Cross sections extend to flow edge for each measurement.

Summary and Discussion of Historical Channel Change

The main observation from the planview mapping is a large decrease in bar (and bare gravel) area along the entire study area between 1939 and 2008. Historical changes in bar area, channel width, and sinuosity have been greatest near the confluence of the North Fork Chetco River, within the Mill Creek and North Fork Reaches, and downstream through the Estuary Reach. The largest changes were between 1965 and 1995, with the periods before and after showing little change or perhaps even opposite trends. The repeat surveys and specific gage analysis indicate that the overall historical vertical change has been bed lowering. Repeat surveys in the estuary show that the channel in 2008 was on average about 0.5 m lower than the channel was in 1939. Similarly, stretches of the Emily Creek, Mill Creek, and North Fork Reaches appear to have channel thalweg elevations up to 2 m lower in 2008 than were measured in the surveys of 1977, with much of the lowering perhaps occurring between 1977 and 1981. The specific gage analysis at FPkm 15.2 (Upper Reach) indicates episodes of aggradation in the late 1970s and late 1990s, but overall a long-term trend of bed lowering.

Many factors are likely responsible for these changes, including (1) direct physical alteration of the river corridor by bank stabilization and development, (2) bars evolving to floodplain by accumulation of overbank sediment and vegetation colonization, (3) changes in the volume of bed-material sediment brought into the study reach from upstream and tributary sources, either because of flow history or drainage basin conditions, (4) changes in the volume of sediment transported out study area by fluvial processes or by dredging and gravel extraction, and (5) floods, which are commonly a catalyst for change.

For the Estuary Reach, the channel and floodplain have been extensively modified by dredging, jetty construction and development between FPkm 0 and 2. Upstream within this reach, commercial aggregate removal may be a factor in decreased bar areas, but bank protection, fill, and development has also reduced bar area.

For the North Fork and Mill Creek Reaches, the planview changes reflect the complicated interplay between the normal pattern of meander growth followed by cutoffs in wandering and sediment-rich rivers (Church, 1983; O'Connor and others, 2003), episodic tributary sediment input from the North Fork Chetco River and possibly Jack Creek, large mainstem floods triggering episodes of channel change, and the direct channel disturbance and indirect consequences of the long history of substantial gravel extraction in this reach. The channel lowering, decreased recent rates of channel migration, diminished bar area, and lesser amounts of bare gravel and sparse vegetation are all mutually consistent changes indicative of transformation from sediment surplus to bed material deficit. Such transformations would promote the conversion of bars to floodplain surfaces as illustrated in figure 21.

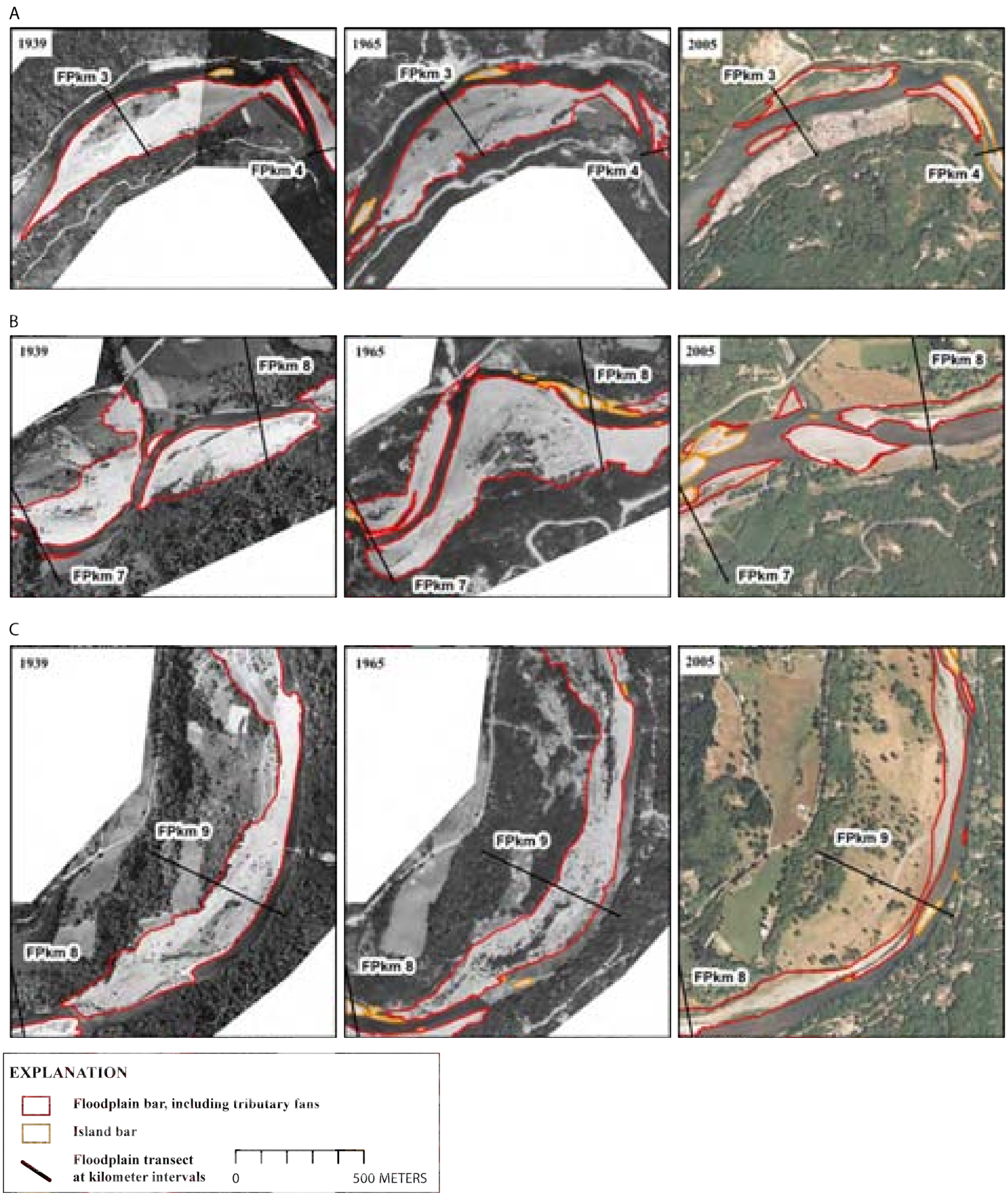


Figure 21. Photographs showing examples of bar evolution to floodplain and developed areas between 1939 and 2005, Chetco River, Oregon. FPkm, Floodplain kilometer. A. Gravel bar near floodplain kilometer 3 (Estuary Reach) evolving to developed area. B. Dynamic bars between floodplain kilometer 7 and 9

(North Fork and Mill Creek Reaches). C. Example of vegetation colonization on upper bar surface near floodplain kilometer 9 (Mill Creek Reach).

The Upper and Emily Creek Reaches have had more stable planforms, reflecting the strong control imposed by the closer valley walls. Although bar elevations were similar in 1977 and 2008, the Emily Creek Reach shows evidence of decreased bar area (fig. 9) and local bed lowering (fig. 18) during between 1939 and 2008. Similarly, the specific gage analysis shows general trends of bed lowering and bar erosion near the gage location in the Upper Reach since the late 1970s (fig. 20). The changes in these two reaches could either be the result of reduced supply from upstream relative to transport capacity or incision propagating from downstream areas where there has historically been substantial gravel extraction.

An important factor in the evolution of channel and floodplain of the lower Chetco River is the history of large flows, since they are probably responsible for bringing in large volumes of sediment and triggering channel change. The largest gaged flow was 2,155 m^3/s on November 19, 1996, but the December 22, 1964, flood with estimated discharge of 2,420 m^3/s (*http://wdr.water.usgs.gov/wy2008/pdfs/14400000.2008.pdf*), was of exceptional duration, and is the largest known flood for the river (Soil Conservation Service, 1979). Anecdotal accounts describe substantial sedimentation along the Chetco River as a consequence of the 1964 flood (Maguire, 2001, p. 9), similar to that documented for several northern California drainages along the Pacific coast (Stewart and LaMarche, 1967; Kelsey, 1980; Madej, 1995). The flood of 1964 in particular caused significant and persistent sedimentation in the Klamath Mountains area because of the great volumes of hillslope material eroded and delivered to the channels during the storm and ensuing flood (Hickey, 1969; Waananen and others, 1971; Lisle, 1981; Harden, 1995). For several southern Oregon and northern California coastal drainage basins, the large volumes of sediment transported to the main channels led to periods of aggradation for mainstem rivers, including the nearby Smith River, for as long as 15 years after the flood, followed by periods of channel incision (Lisle, 1981). Some of the changes seen on the lower Chetco River, such as the late 1970s aggradation at the streamflow measurement station and the subsequent channel lowering (and the attendant reduction in bar areas) may be a similar decadal time-scale response to this particularly significant flood.

Bed Material: Characterization, Transport, and Budget

Partly building on the channel mapping, a primary objective of this study was to estimate the volume of bed material entering the lower Chetco River and the distribution of this material as it is transported and deposited within the study reach. Because of the multiple uncertainties and factors in such an analysis, we have adopted multiple measurement and analysis approaches. The overall analysis framework is that of a sediment budget (for example, Reid and Dunne, 1996, 2003), accounting for the various inputs and outputs of bed material affecting the 16-km-long study reach.

The analysis focused on bed material, the sediment found along the bed of the active channel. For the Chetco River, bed material includes the substrate of the low-flow channel and the flanking gravel bars, and consists chiefly of sand and gravel (clast diameters greater than 0.063 mm and ranging up to 250 mm). These materials are transported through the river corridor primarily as bedload by bouncing, sliding, or rolling along the bed, although some sand (clasts with diameters between 0.063 and 2 mm) may be transported as suspended load, supported higher in the flow by turbulence. The specific factors that require consideration for a bed-material budget are the (1) volume of bed material transported into the reach from upstream, (2) volume of bed material transported directly into the reach by tributaries, (3) volume of bed material leaving the reach by fluvial transport into the Pacific Ocean, (4) volume leaving by other means (dredging, gravel extraction), (5) change in storage within the reach (owing to channel and bar deposition and erosion), and (6) attrition of bed-material clasts by mechanical breakage as they are transported and conversion of some mass of the bed-material load to finer materials. Adding to the challenge posed in considering all these factors is that the fluxes can vary tremendously in space and time (Gomez, 1991).

Two independent approaches were applied to assessing bed-material transport rates and storage throughout the study reach: (1) a transport equation approach in which bed material transport was calculated on the basis of prescribed flow, channel geometry, and sediment conditions, and (2) a mapping based approach in which bed material fluxes were estimated from spatial and temporal changes in the volume of stored sediment along the study reach. Underlying these approaches were basic characterization of the sediment and flow conditions, in addition to the mapping of active channel features as described above.

Bed Material Characterization and Source

There were two objectives in characterizing the bed material. The first was to assess the size distribution of the bed material to support analyses of transport rates and bar-surface armoring. The second was to assess sediment sources and possibly particle attrition rates by evaluating spatial patterns in clast lithology.

Gravel Distribution and Textures

A robust description of the Chetco River bed material is central to understanding overall patterns of sediment storage along the study area. Particle size information also supports sediment flux calculations by bedload-transport equations, as well as inferences of relations between sediment supply, channel morphology, and shear stress (for example, Dietrich and others, 1989; Lisle and others, 2000).

The active gravel bars along the Chetco River study area are expansive (figs. 3, 8, and 21), some extending for lengths greater than 1 km with widths exceeding 0.25 km. The total bar area within the study reach in 2008 is about 0.9 km^2, approximately equal to the total low flow channel area. The mean bar height above the channel thalweg, as determined from the mapping, LIDAR, and longitudinal profile survey, is 3 m.

Sampling

Bed-material textures were characterized by sampling 12 mainstem Chetco River gravel bars along the length of the study reach during September 2008. These data were supplemented by measurements at three tributary channels (table 4). For each of these bars, surface-particle sizes on the bar apex were measured. For three of the Chetco River mainstem bars, additional surface samples at the middle and downstream areas of the bar were measured, and substrate was sampled at the bar apex (table 4). Surface material sampling was by a modified grid technique (Kondolf and others, 2003), measuring grain size for 200 particles at 0.3-m increments along two parallel 30-m tapes. The tapes were spaced 1–2 m apart and were aligned parallel to the long axis of the bar. Clast measurements were by aluminum template (Federal Interagency Sediment Project US SAH-97 Gravelometer).

Table 4. Sediment sampling locations used in the sediment transport study, Chetco River, Oregon—continued

[Samples collected on September 15-19, 2008, using methods of Wolman (1954). Unless otherwise noted, samples were taken at bar apices. Eastings and northings are in meters and refer to the UTM zone 10 projection using the North American Datum of 1983. **$d_{16:}$** grain size diameter in millimeters, where 16% of the sample is finer by volume. **$d_{50:}$** grain size diameter in millimeters, where 50% of the sample is finer by volume. **$d_{84:}$** grain size diameter in millimeters, where 84% of the sample is finer by volume. Location names are informal descriptions of bars based on local landmarks.]

Sample ID	Location	River kilometer	Floodplain kilometer	Easting	Northing	Sample Type	d_{16}	d_{50}	d_{84}
1a	Fitzhugh Bar	17.4	16.3	402185	4664607	surface	7.76	47.19	103.57
						subsurface	2.27	31.08	121.87
1b	Fitzhugh Bar; midbar	17.3	16.0	402067	4664588	surface	10.00	31.72	72.21
1c	Fitzhugh Bar; bar toe	17.0	15.3	401898	4664363	surface	16.73	40.91	74.54
2	Second Bridge Bar	16.7	15.1	401900	4664111	surface	11.52	28.87	57.42
3	Emily Creek Bar	14.5	13.2	401916	4663279	surface, tributary	7.08	22.14	47.00
4	Loeb Park Bar	14.3	13.0	401955	4662994	surface	17.98	37.15	63.07
5	Tamba Bar	12.4	11.3	401353	4661413	surface	10.14	36.33	72.13
6	Mill Creek Bar	10.5	9.5	401281	4659622	surface	20.95	53.26	89.40
7	Freeman Bar	8.6	7.8	400003	4658583	surface	24.26	57.83	101.94
8	North Fork Bar	8.3	7.6	399729	4658916	surface, tributary	16.24	39.22	96.55
9	Jack Creek Bar	6.5	5.9	398949	4657514	surface, tributary	15.38	31.43	70.50
10a	Social Security Bar	6.7	6.1	398602	4657732	surface	14.21	39.72	85.94
						subsurface	1.51	19.01	59.43
10b	Social Security Bar; midbar	6.3	5.6	398249	4657614	surface	4.32	18.89	39.48
10c	Social Security Bar; bar toe	6.0	5.4	397969	4657655	surface	10.10	19.75	37.96
11	Tide Rock Bar	5.1	4.4	397114	4657964	surface	6.15	23.88	58.76
12a	Tidewater Estuary Bar	3.5	2.9	396039	4658364	surface	1.80	17.26	45.00
						subsurface	0.89	7.17	31.29
12b	Tidewater Estuary Bar; mid-bar	3.4	2.9	395999	4658335	surface	3.87	16.18	38.50
12c	Tidewater Estuary Bar; bar	3.3	2.8	395903	4658268	surface	3.45	11.91	28.42

Table 4. Sediment sampling locations used in the sediment transport study, Chetco River, Oregon—continued

[Samples collected on September 15-19, 2008, using methods of Wolman (1954). Unless otherwise noted, samples were taken at bar apices. Eastings and northings are in meters and refer to the UTM zone 10 projection using the North American Datum of 1983. **d_{16}:** grain size diameter in millimeters, where 16% of the sample is finer by volume. **d_{50}:** grain size diameter in millimeters, where 50% of the sample is finer by volume. **d_{84}:** grain size diameter in millimeters, where 84% of the sample is finer by volume. Location names are informal descriptions of bars based on local landmarks.]

Sample ID	Location	River kilometer	Floodplain kilometer	Easting	Northing	Sample Type	d_{16}	d_{50}	d_{84}
	toe								

Subsurface samples were collected to assess the difference between the bed surface and subsurface textures (a measure of “armoring”) and to support transport calculations with substrate-based bed-material transport equations. Subsurface samples at the bar-apex surface-sample measurement sites were collected from three bars—Fitzhugh Bar (FPkm 15.7), Social Security Bar (FPkm 6.0), and Tidewater Estuary Bar (FPkm 3.0) (table 4). Each subsurface sample was collected by removing the surface layer, consisting approximately of the depth equivalent to the median surface particle diameter, and then collecting 15–20 L from an excavation approximately 40 cm deep and 20 cm in diameter. Subsurface-sample masses ranged from 33 to 39 kg, and are probably not large enough to adequately characterize the distribution of clasts greater than 64 mm (Church and others, 1987; Kondolf and others, 2003). These samples were dried, sieved, and weighed by the USGS sediment laboratory in Vancouver Washington. For each of the subsurface samples, there was one clast in the largest size bin, accounting for 15 percent, 5 percent, and 2 percent of the samples at Fitzhugh Bar, Social Security Bar, and Tidewater Estuary Bar, respectively. For Fitzhugh Bar in particular, this single large 128–256 mm clast forms a relatively large proportion of the total sample, possibly biasing the gradation curve to larger values and resulting in a calculated d_{50} (and other percentile) values larger than would be derived from a larger sample, which would presumably have a relatively smaller volume in the largest size categories.

Assessment of Bed-Material Sizes

For all the mainstem Chetco River bar-apex surface samples, the median particle diameter (D_{50}) ranges from 57 mm to 17 mm (fig. 22). The three tributary samples were also bracketed by this range. The surface material size distributions show a trend of coarsening between FPkm 14.5 and the confluence of the North Fork Chetco River at FPkm 7.6, followed by fining towards the estuary (FPkm 3). For the three bars with multiple surface samples, median particle size decreases by approximately 30–50 percent along the length of the individual bars (fig. 23). The bar apices appear to also show bimodal size gradations, as the apex sites have similar or greater amounts of fine sediments (less than 10 mm) than the distal bar sites, probably owing to sand and fine gravel deposition on these typically lower elevation sites by waning or later smaller flows after bar mobilization events.

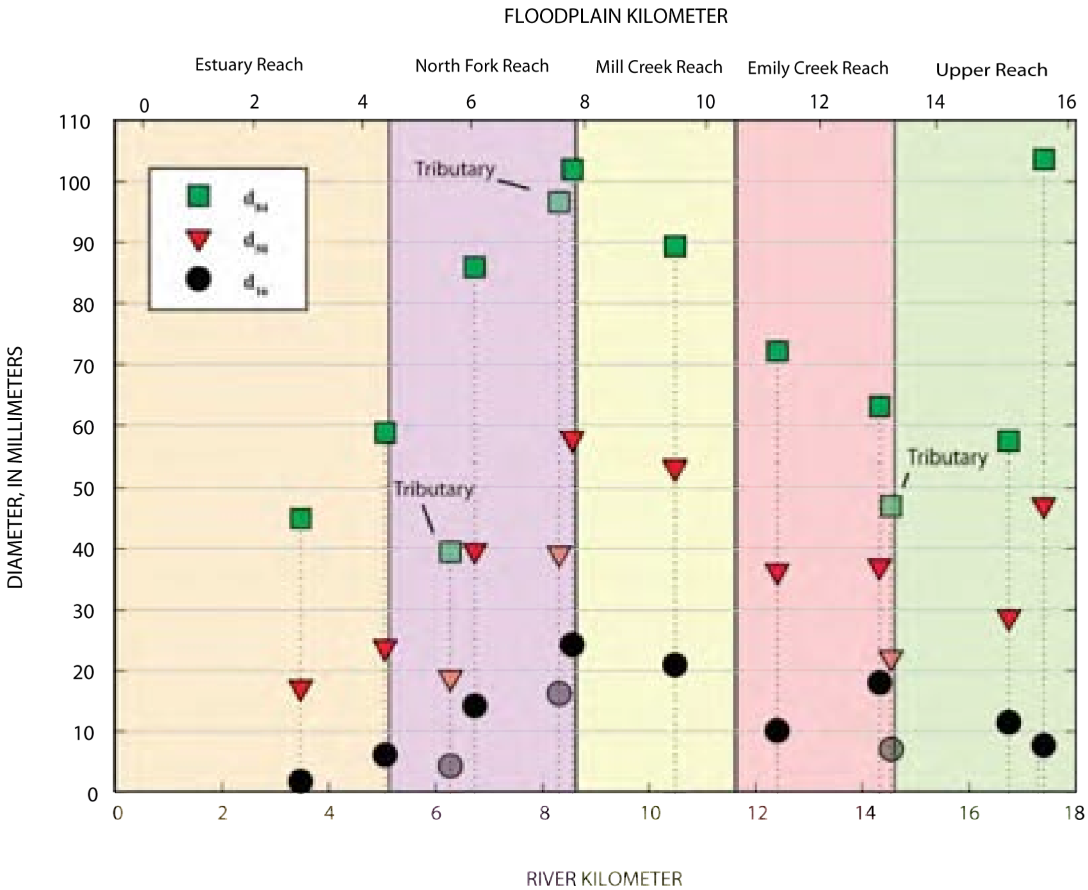


Figure 22. Graph showing longitudinal variation in surface-particle size for bar apices along the Chetco River, Oregon, study area. Surface material was sampled at 12 mainstem Chetco River gravel bars and 3 tributary channels using Wolman (1954) particle count procedure with measurement template.

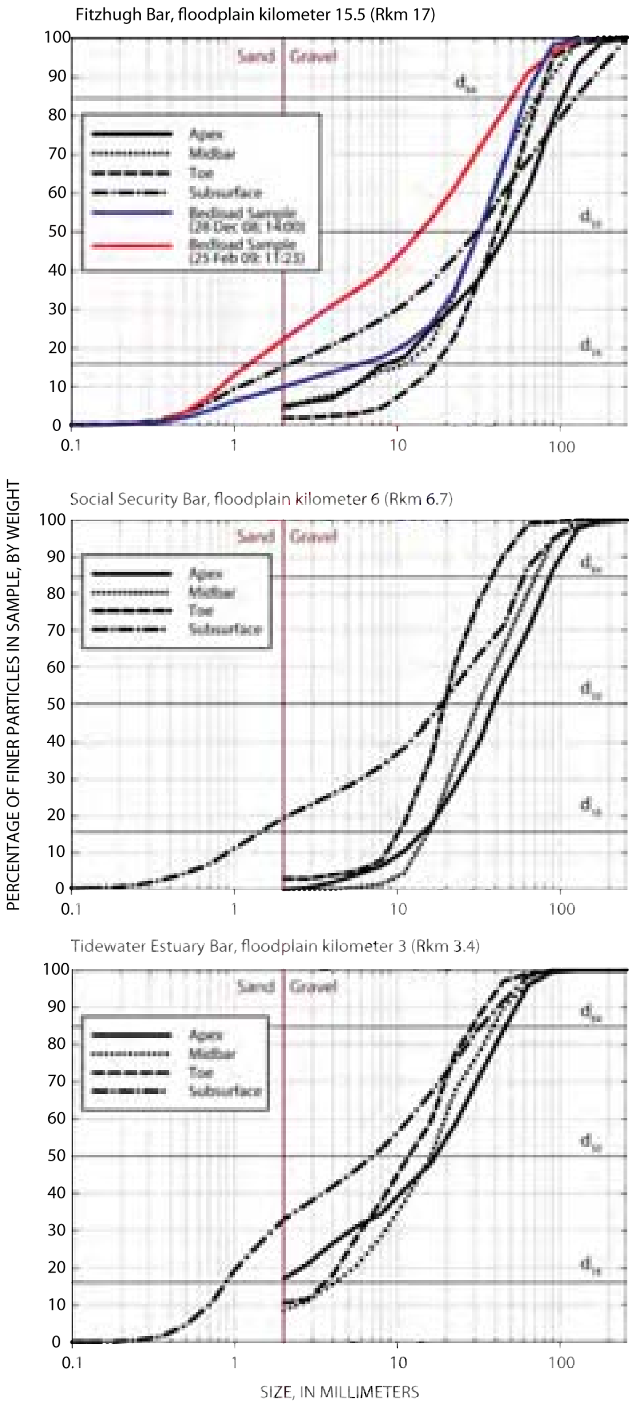


Figure 23. Graphs showing particle size distributions for surface and subsurface samples at Fitzhugh Bar, (floodplain kilometer 15.5), Social Security Bar (floodplain kilometer 6.7), and Tidewater Estuary Bar (floodplain kilometer 3), Chetco River, Oregon. At each bar, surface material was sampled at three locations along the bar axis: bar apex, midbar, and toe of bar using Wolman (1954) particle count procedure with measurement template. Subsurface material sampled volumetrically at bar apex and sieved by USGS sediment laboratory in Vancouver, Washington. Bedload sample size distributions for December 28, 2008, and February 25, 2009, sampling trips shown for comparison with the surface and subsurface samples from the nearby Fitzhugh Bar. Bedload samples analyzed by USGS sediment laboratory in Vancouver.

The three subsurface samples were substantially finer than the surface-material samples measured at the same locations (fig. 23). Previous studies have shown that the relative coarseness of the surface layer increases as a function of the excess transport capacity and that reaches where sediment supply exceeds transport capacity should have little to no armoring, whereas reaches with excess capacity would display increasing levels of armoring (Dietrich and others, 1989; Buffington and Montgomery, 1999). Although the exact relations are uncertain, the degree of armoring (defined as the ratio of d_{50} surface material to d_{50} substrate) can be used as an indication of sediment supply relative to transport capacity (Bunte and Abt, 2001). In general, armoring ratios close to 1 indicate high sediment supply, whereas channels with excess transport capacity typically have armoring ratios greater than 2 (Bunte and Abt, 2001). On the Chetco River, armoring ratios at Fitzhugh Bar, Social Security Bar, and Tidewater Estuary Bar were 1.52, 2.09, and 2.41 respectively, indicating high sediment supply relative to transport conditions at the upstream end of the study reach (although the Fitzhugh Bar armoring ratio may actually be higher if the subsurface sample is biased as described above) but perhaps excess transport capacity relative to sediment supply in the North Fork and Estuary Reaches. The increasing ratio of median surface layer diameter to subsurface median diameter is also counter to typical conditions where armoring ratios decrease with channel slope (Pitlick and others, 2008), a possible indication of downstream changes in sediment supply relative to transport capacity.

Bed Material Lithology and Sources

An important component of the overall sediment budget is the volume of material entering the study reach by tributaries. At the upstream end of the study reach, the contributing drainage area is 702 km^2, 77 percent of the total basin area at the mouth. The largest tributaries are Emily Creek (FPkm 13.2, drainage area 32 km^2), North Fork Chetco River (FPkm 7.6, drainage area 104 km^2), and Jack Creek (FPkm 5.8, drainage area 22 km^2), together accounting for 158 km^2 of the 211 km^2 of drainage area gained by the Chetco River through the study reach. All three of these tributaries have small fans at their junction with the mainstem Chetco River that have episodically grown and eroded, indicating that bed material is entering from these tributary catchments. The simplest approach to estimating the volume of bed material entering by the tributaries is to assume that it is proportional to contributing area. However, this assumption fails to account for possibly different sediment production rates within the drainage basin owing to geology, physiography, and land use (Maguire, 2001). To independently assess the contributions of tributaries, clast lithology at all sites of particle size analysis were evaluated, taking advantage of the distinct geologic terranes contributing sediment to different parts of the drainage basin.

For all bed-material size measurements, we classified clasts greater than 11 mm according to lithology. The lithologic classifications used in this study were not complete identifications traceable to specific geologic units, but simple categories facilitating rapid and consistent hand sample identification. A total of 16 lithologic categories were developed, but 3 of these categories—quartzite (metasandstone), sandstone, and basalt—dominated the total assemblage of particles sampled. Surface material was classified in the field during the particle size counts, and lithologies of subsurface material were determined on the sieved samples after size analysis by the USGS sediment laboratory.

The dominant clast type for all mainstem sampling sites was a dark grey and very hard metasedimentary rock designated as "quartzite," composing 50–80 percent of most mainstem samples (fig. 24), followed by fine- to coarse-grained lithic sandstones typically composing 20–40 percent of the sampled clasts. Both of these clast types are likely derived mainly from the Dothan Formation, which underlies the western half of the drainage basin, and enter the study reach from upstream as well as from tributaries. Several clast types are unique to the upper drainage basin and the mainstem Chetco River at the upper end of the study reach, including coarse-grained igneous and metamorphic rock, and ultramafic rocks, but they typically compose less than 10 percent of the sampled rock types. We sampled bed material at the three major tributaries, Emily Creek, North Fork Chetco River, and Jack Creek, for which the percentage of sandstone was greater than for most of the mainstem sample sites.

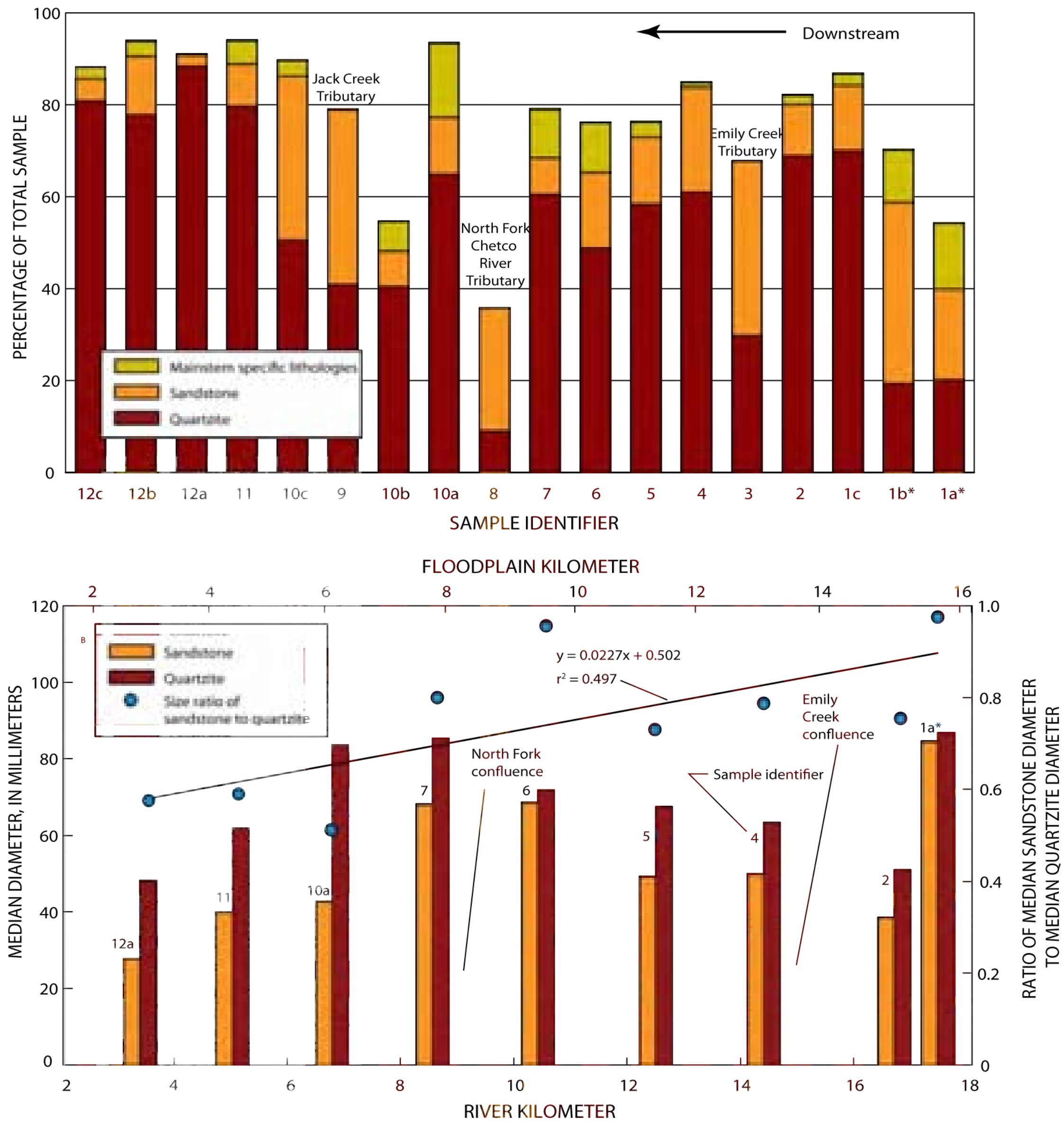


Figure 24. Graphs showing variation in clast lithology and size ratio of sandstone and quartzite clasts for sites along the Chetco River, Oregon, study area. A. Variation in clast lithology for each of the 18 surface-material samples taken from 12 bars along the mainstem Chetco River and 3 tributary bars. Sample locations reported in table 4, but locations proceed downstream in order of sample identifier. Samples 1b and 1a done with slightly different protocol, so results not directly comparable. Totals do not sum to 100 percent because unidentified and minor local clast types are not included. B. Median diameter (d_{50}) of sandstone and quartzite particles at each of the mainstem Chetco sites where surface material was sampled, and downstream trend in the ratios of median diameters. The ratios of sandstone to quartzite d_{50} at each site indicate a general downstream trend of decreasing sandstone size relative to quartzite size.

The small number of distinctly upper-basin classes and their variation among samples precludes strong inferences regarding the contribution of bed material by the tributaries except that the presence of these clast types in relatively similar percentages all the way to the estuary indicates that the bed material brought in by tributaries is not a substantial percentage of the sampled distributions. A mixing model analysis of the ratio of sandstones to quartzites applied to samples from Emily Creek and North Fork Chetco River with adjacent mainstem samples indicates that the North Fork contributes up to 7 percent of the total bed-material volume at its confluence (compared to the 12 percent of the total basin area at the confluence), and that Emily Creek contributes 7–31 percent at its confluence (compared to the 4.4 percent of the total basin area at the confluence), although these values are highly sensitive to the choice of local mainstem distributions. Given the ranges permitted by this analysis, it is assumed that bed material sediment influx from tributaries is related to drainage area, indicating that about 25 percent of the bed material in the study reach is contributed by local tributaries.

Bed-material Particle Attrition

In opposition to the bed material introduced by tributaries is the wearing down of bed material by fracture, abrasion, dissolution, and weathering as it moves downstream. Particle attrition reduces bed material sediment volumes because some of the finer particles created by mechanical breakage will become part of the suspended load that leaves the active channel environment for either overbank floodplain deposition or the Pacific Ocean. Primary evidence for such attrition is the downstream fining of bed material typically seen in gravel-bed rivers (Mackin, 1948; Schumm and Stevens, 1973), made stronger by instances of differential fining of distinct clast lithologies (Plumley, 1948; Shaw and Kellerhals, 1982; Kodama, 1994). Many studies, however, have shown that such fining results chiefly from sorting by selective deposition (Paola and others, 1992; Hoey and Ferguson, 1994; Rice 1999). For the Chetco River, a decreasing trend in the size of sandstone clasts relative to quartzite clasts in the downstream direction indicates some particle breakdown (fig. 24). Although complicated by many factors such as the introduction of tributary sandstone clasts, the approximately 40 percent reduction in particle diameter for the sandstone clasts relative to quartz would indicate nearly an 80 percent volume reduction of sandstone. If the sandstone clasts were the only clast type with significant attrition, the volume reduction of the gravel would be less than 10–20 percent given the small percentage of sandstone composing the greater than 11mm sediment.

We also assess downstream volume loss by applying the attrition coefficients provided by (1) Shaw and Kellerhals (1982) for the fractional diameter reduction of quartzites in natural rivers of 0.0017/km, giving an volume reduction of 5.5 percent for length of channel between FPkm 15 and 5; and (2) the experimental tumbler results by Collins and Dunne (1989) for Olympic Peninsula rocks that indicate fractional diameter reduction rates equating to a 10–30 percent volumetric reduction by abrasion between FPkm 15 and 5. We judge the Collins and Dunne (1989) attrition rates to be the maximum plausible volumetric reduction because of the likely greater hardness of the Chetco River bed materials. Taken together, we judge the volumetric bed-material attrition rate along the length of the Chetco River study reach to be between 5 and 30 percent.

Flow Modeling

The driver of bed-material transport is streamflow, including the temporal sequence of high flows over the years and the spatial distribution of hydraulic conditions along the channel. The sequence of past flows for the Chetco River comes from records of the USGS streamflow measurement station at FPkm 15.2 (fig. 2). To determine the spatial distribution of hydraulic conditions produced by this range of flows on the Chetco River, we constructed a one-dimensional hydraulic model of the study reach. The results from this model support the equation-based predictions of bed-material transport described subsequently.

For the Chetco River study area, we applied the Hydrologic Engineering Center's River Analysis System (HEC-RAS) Version 4.0 model (U.S. Army Corps of Engineers, 2006). The HEC-RAS model calculates one-dimensional (cross section averaged) energy-balanced water surface profiles for a series of cross sections and specified discharges and energy loss coefficients. Calculated values include cross-section-average water-surface elevations and energy slopes (S_f) for each cross section. For applications in subcritical flow regimes, calculations proceed upstream.

For this analysis, valley-bottom geometry was defined using 68 cross sections between FPkm 0.5 and FPkm 15.5. Cross sections spanned the entire valley bottom and were spaced at intervals approximately equal to the active channel width (typically about 300 m), but with a maximum spacing of 900 m. The cross sections were developed from the LIDAR merged with bathymetric surveys, both from 2008, and from streamflow measurement surveys at the USGS streamflow measurement station. The upstream-stepping flow computations for each simulated discharge were started at normal depth at the downstream cross section at FPkm 0.5. Discharge was assumed to increase by 14 percent at the North Fork Chetco River confluence at FPkm 7.6, consistent with incremental area contributed by this basin relative to the drainage area at the upstream end of the reach. Flow from other tributaries entering the Chetco River within the study area was not considered because the North Fork Chetco River is the only tributary basin with large enough area likely to contribute significant discharge at, or near, the same time that discharge in the mainstem Chetco River is peaking.

The HEC-RAS model was calibrated by comparing the calculated water-surface elevations to the rating curve in use during the summer of 2008 at the USGS Chetco River streamflow measurement station at FPkm 15.2 near the upstream end of the modeled reach. A suitable fit resulted from applying Mannings *n* values of 0.04 to the channel bed and banks for the entire study reach. The calculated profiles from this model closely match the water-surface profile determined from the LIDAR survey of 2008, when flow was approximately 7.8 m^3/s according to the stage-discharge relation at the USGS gage, as well as water-surface elevations during the December 29, 2008, flow of 1,440 m^3/s. From this calibrated model, water-surface elevation and S_f were calculated for each of the 68 cross sections and for 20 discharges ranging between 5.5 and 2,270 m^3/s, encompassing the range of flows likely to transport bed material as well as all recorded flood peaks since 1970 (fig. 25).

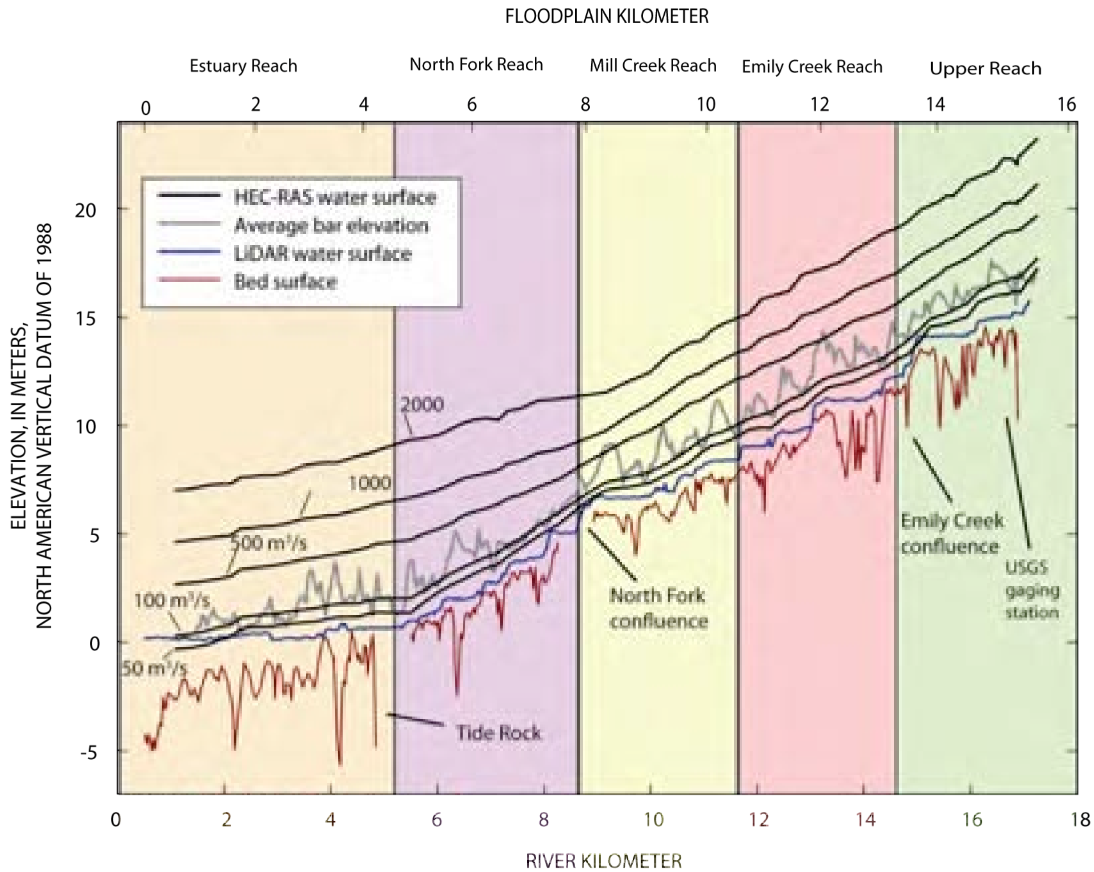


Figure 25. Graph showing surveyed channel thalweg in 2008 (USGS survey), water-surface (from LIDAR, discharge approximately 7.8 cubic meters per second), bar surfaces (from LIDAR), and calculated water-surface profiles for flows between 50 and 2,000 cubic meters per second for the lower Chetco River, Oregon.

The calculated water-surface and energy profiles generally match the thalweg and low-flow water-surface profiles, but become more regular with increasing discharge (fig. 25). This transformation owes to the decreasing influence of channel morphology, such as pool-and-riffle geometry, and increasing influence of overall valley geometry on flow hydraulics as discharge increases. Because of the specified downstream boundary condition of normal depth, the modeling results do not account for the approximately 2 m tidal range affecting the Estuary Reach, which has a significant effect on low flows but is unlikely to affect mean sediment transport conditions during high flows. All profiles show a gradient inflection: For low flows, this corresponds to the upstream limit of tidal influence and a slight change in thalweg slope near FPkm 5; for higher flows, this inflection moves upstream into the Mill Creek Reach, approaching FPkm 10 for flows of 2,000 m^3/s, corresponding to the significant increase in valley-bottom width near the North Fork confluence. This change in slope has important implications for reach-scale bed-material transport. The flow modeling also shows that most bars are inundated by flows of 250–500 m^3/s.

Direct Measurement of Bedload Transport

Although challenging and subject to many uncertainties, direct measurement of bedload transport can substantially aid estimates of annual fluxes of bed material (Hicks and Gomez, 2003). An ideal situation is to make numerous bedload transport measurements over a range of flows so as to produce a bedload rating curve relating bedload transport rates to river flow (for example, Emmett, 1980; Wilcock and others, 1996; Pitlick and others, 2008). This process requires multiple measurements, possibly over several years to encompass the necessary range of flows, and is especially difficult for rivers such as the Chetco River in which sediment transporting flows are in response to short duration rainfall events. As a consequence, the purpose of making bedload measurements on the Chetco River was not to develop a bedload transport rating curve but solely to aid in selection of bedload transport equations as described in the following sections. The measurements reported here, however, could be incorporated into a bedload rating curve as part of a sustained measurement program.

Sampling

Two measurement trips were completed during winter 2008–09. The measurements were made from the bridge crossing the river at the USGS streamflow measurement site at FPkm 15.2, near the upstream boundary of the study reach. The channel here makes a sweeping left bend, with the low flow channel abutting steep bedrock of the valley wall, and the left side formed by an active gravel bar inset against vegetated floodplain. For sampling, we used an 80 kg TR-2 bedload sampler with a 30-cm-wide by 15-cm-tall opening with a 0.5 mm mesh collection bag (fig. 26). The TR-2 sampler was designed by the USGS in 1986 to sample coarse sand and gravel in the vicinity of Mount St. Helens after the 1980 eruption (Childers, 1992), and has size and weight characteristics appropriate for the high flows and coarse sediment loads typical of the Chetco River. The sampler was suspended from the bridge with a truck-mounted hydraulic winch. The nose of the sampler was stabilized by a line running through a wheeled pulley riding a stay line crossing the river approximately 30 m upstream, with the free end controlled by personnel on the bridge deck.

Figure 26. Photographs showing bedload sampling at USGS streamflow gaging station Chetco River near Brookings, Oregon (14400000), Chetco River, Oregon, December 28, 2008. Streamflow was 1,170 cubic meters per second. (Photographs by Jim O'Connor, U.S. Geological Survey, December 28, 2008.) A. View

of sampling equipment, including truck and sampler, during deployment; cable in view is for discharge measurements and was not used for bedload sampling. B. TR-2 sampler after sample collection.

Sampling protocols were modified from the single-equal-width-method prescribed by Edwards and Glysson (1999) to account for time limitations. For each sampling transect, the cross section was sampled by 8–10 verticals [in contrast to the 20–40 verticals recommended by Edwards and Glysson (1999)] spaced at 4.6–6.1 m apart. The sampler was placed on the bed for 30 seconds for each sample. The intent was to make multiple transects for each measurement, but time and equipment limitations allowed only one complete (or nearly complete) transect for each measurement. The sampler was emptied after most individual vertical measurements, except for near the flow edges where there was little material collected. Samples were dried, weighed and sieved by the U.S. Geological Survey Sediment Laboratory in Vancouver, Washington (table 5). Transport rates were calculated by

$$Q_b = M \times \frac{\left[\frac{W}{(n \times w)}\right]}{T}, \quad (1)$$

where Q_b is the bedload transport in kilograms per second, M is the sample mass in kilograms, T is the sample time (for each vertical) in seconds, W is the wetted width in meters, n is the number of verticals, and w is the width of the sampler in meters.

Table 5. Summary of bedload measurements for winter 2008–09, Chetco River, Oregon

[Measurements at U.S. Geological Survey streamflow measurement station 14400000 with TR-2 sampler; using modified version of single equal-width-increment method of Edwards and Glysson (1999). Abbreviations: kg, kilograms; mm, millimeters; m^3/s, cubic meters per second, m, meters; kg/s, kilograms per second; --, no data]

Sample transect (date and start time)	Number of verticals	Sample mass (kg)	Median particle size (mm)	Water discharge (m^3/s)	Channel width (m)	Bedload discharge (kg/s)	Comments
12/28/2008 at 11:00	10	102.4	31	1,190	70	78.4	Poor sampler contact with channel bed for some verticals
12/28/2008 at 14:00	10	193.9	13	1,120	70	148.4	Good sampler contact with channel bed for most verticals
2/24/2009 at 11:23	9	21.6	0.8	290	60	15.7	Sampler support cable failed at vertical 8; calculation assumes no material for verticals 8 and 9, so this should be considered a minimum value

The first measurement trip was December 28–29, 2008, during a wet storm producing high flows along the southern Oregon coast. Flow on the Chetco River rose from about 105 m^3/s early on December 27 to a peak of 1,200 m^3/s at 12:15 on December 28, before decreasing to about 880 m^3/s by midnight of December 28. Flow then rose again, peaking even higher at 12:15 on December 29 with a discharge of 1,450 m^3/s. For comparison, the 2-year and 5-year recurrence-interval flows on the Chetco River are 1,060 and 1,425 m^3/s respectively (fig. 27). During these flows, depths exceeded 12 m and surface velocities were greater than 3 m/s. Two measurement transects were completed on December 28. The first, between 11:00 and 13:10, spanned the peak flow for the day. Because it was difficult to maintain the stability of the sampler in the water and to be certain that it was securely on the channel bed (severe drag on the supporting cable and stay-line prevented detectable slackening of the support cable when the sampler grounded), this measurement is considered inferior to the second measurement of the day, between 14:00 and 16:06, in which the sampler maintained better position and contact with the bed. An attempted measurement during the higher flow of December 29 was unsuccessful because the velocities and flow depths prohibited the sampler from reaching the channel bottom in a controlled manner.

The second measurement trip was on February 24, 2009, in the midst of several days of elevated flow following a late winter frontal system that crossed the Chetco River drainage basin. Flow rose from less than 30 m^3/s early on February 21 to a peak of 450 m^3/s at 18:00 on February 23 before dropping overnight. During the February 24 sampling between 11:23 and 12:17, flow was steady at 290 m^3/s for the entire measurement period (fig. 27). This flow has been exceeded on a mean daily basis for 4.4 percent of the period October 1, 1969–March 5, 2009. For this bedload measurement, with much less intense flow than the December 28–29 event, sampling proceeded well, with solid contact with the bed, until the 8th (and penultimate) vertical near the right bank, when the sampler support cable failed, halting completion of the transect. The partial results are reported in table 5 and the calculated transport rate should be considered a minimum value, although the two missing verticals would add negligibly to the total judging from (1) the relative contribution of load from that part of the cross section during the December 28 measurements, (2) the trend of sample masses from this transect, and (3) acoustic Doppler "moving bed" measurements made later in the day (fig. 28).

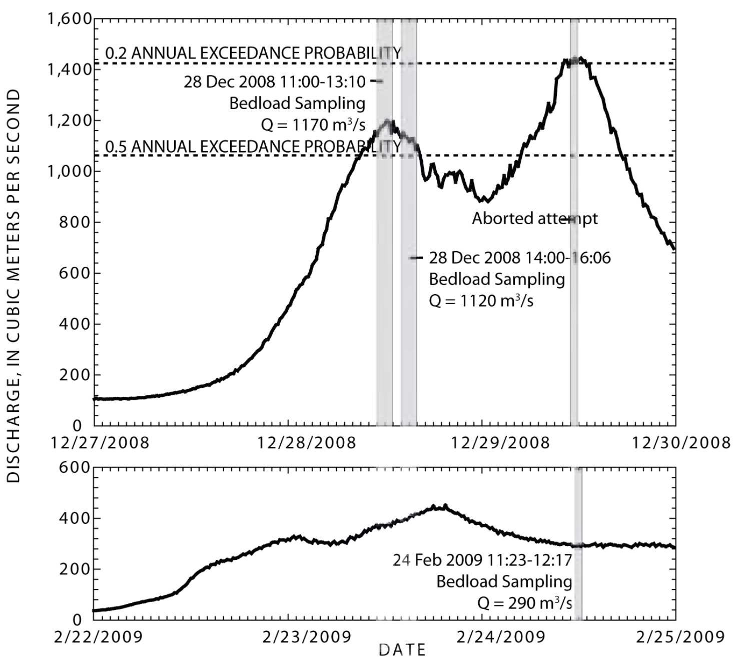


Figure 27. Graphs showing flow and sampling periods for bedload measurements on the Chetco River, Oregon. A. December 29–30, 2008, sampling periods, also showing flow exceedance probabilities as calculated following Bulletin 17 guidelines from annual peak flows for the period 1970–2007. B. February 24–25, 2009, sampling period.

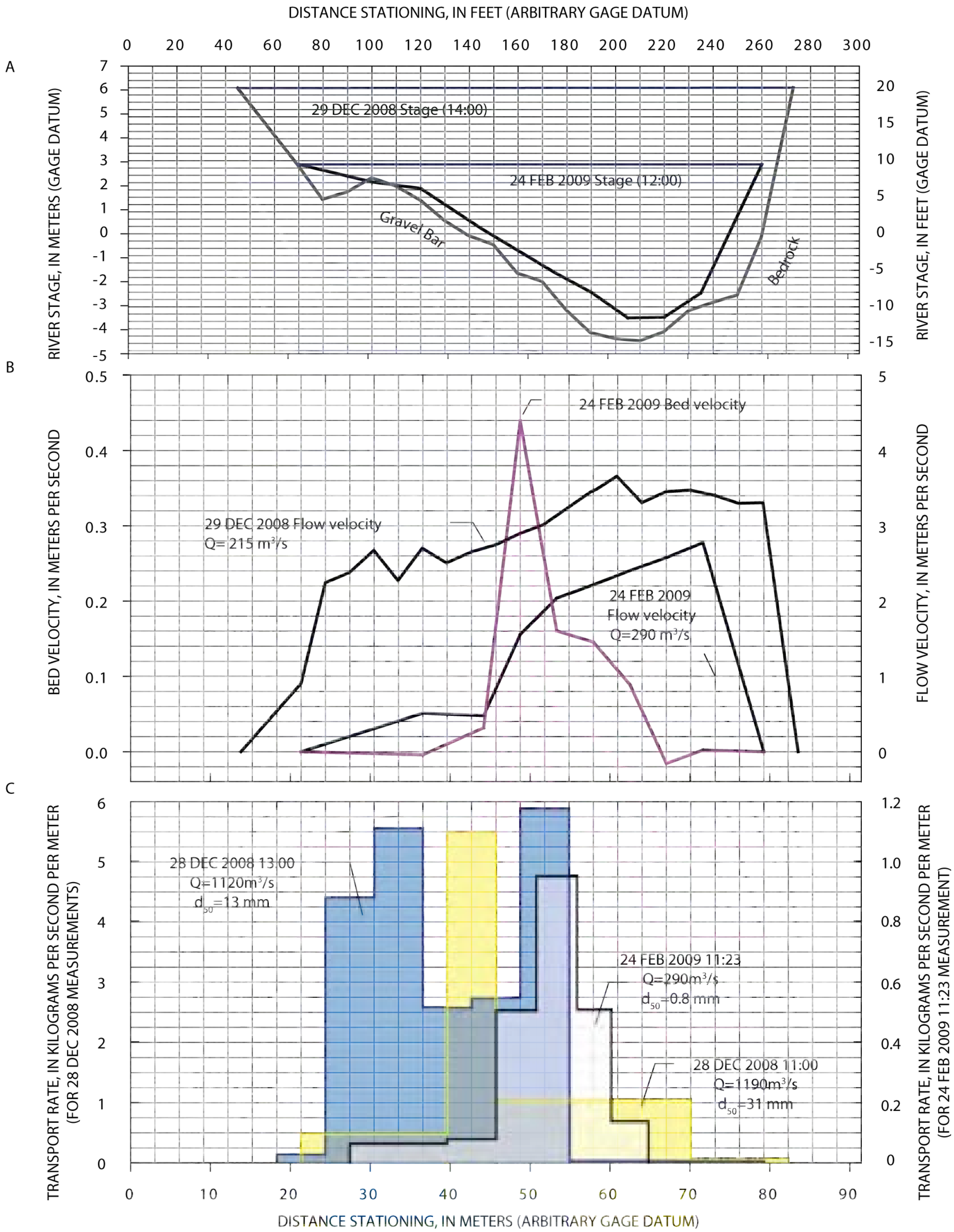


Figure 28. Graphs showing summary flow and bedload transport data for December 28–30, 2008, and February 24–25, 2009, measurements, Chetco River, Oregon. A. Channel cross-sections, from December 29–30, 2008, and February 24–25. 2009, soundings, with measured water surface elevations. B. Depth-averaged mean velocity from 29 December 29, 2008, and February 24, 2009, measurements, and February 24 moving-bed velocity, as measured by acoustic Doppler current profiler. C. Measured unit bedload transport rates by sampling vertical; several verticals were composited for the December 28, 2008, 11:00

measurement, reducing spatial resolution. Bulk of transport for this measurement was between stations 40 and 55.

Results and Discussion of Bedload Sampling

Despite the sampling difficulties and incomplete results, the measurements show high rates of coarse bedload transport at high flows (fig. 28, table 5). The transport rate for the December 28 14:00 measurement, corresponding to a flow slightly exceeding the 2-year recurrence-interval discharge, was nearly 150 kg/s, with an average unit transport rate of 2.1 kg/m/s. As expected, the transport rate of the lower flow of February 24, 2009, was much lower—only 15.7 kg/s and a unit transport rate of 0.26 kg/m/s. The transport rate calculated from the December 28 14:00 measurement is higher than nearly all reported examples of high bed load transport rates on western U.S. gravel-bed stream and rivers—which typically range up to about 0.4 kg/m/s—but is less than the 3.9 kg/m/s measured for the North Fork Toutle River in a drainage basin tremendously disturbed by the 1980 Mount St. Helens eruption (Pitlick, 1992; Pitlick and others, 2009). The measured transport rate at the highest flow, 1,190 m^3/s, was substantially lower than the one later in the day at a slightly lower flow, but this owes to poor sampler contact with the bed for several of the measurement verticals. Evident from all measurements, including the "moving bed" Doppler measurement also made on February 24, 2009, is that most bed-load transport was over the gravel bar forming the left bank, despite higher velocities in the channel thalweg (fig. 28).

The median particle size of the bedload scaled with water discharge, with the median particle size for the December 28, 2008, measurements ranging from 13 to 31 mm, whereas sediment collected during the February 24, 2009, high flow was chiefly sand with a median diameter of 0.9 mm. The D_{84} for the December 28, 2008, 11:00 and 14:00 measurements were 50 and 60 mm respectively, slightly finer than the 70- to 110-mm D_{84} values for surface and subsurface bed-material samples collected from Fitzhugh bar, 0.5 to 1 km upstream (fig. 29). Although bedload is typically finer than the surface material and is closer in size to subsurface material (Lisle, 1995), it is possible that the TR-2 sampler, with its 152- by 305-mm opening, was undersampling the largest clasts. Alternatively, still higher flows may be required to transport the coarsest particles in this reach.

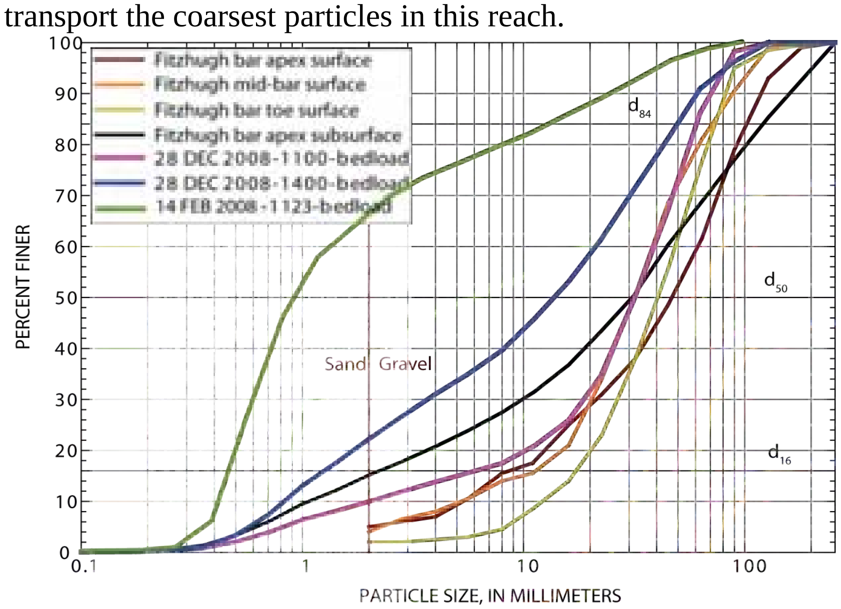


Figure 29. Graph showing particle size distributions for sampled bedload and Fitzhugh Bar (floodplain kilometer 15.5) surface and subsurface measurement, Chetco River, Oregon. Bedload and Fitzhugh Bar

subsurface gradations from sieve analysis by USGS sediment laboratory in Vancouver, Washington; surface gradations from Wolman (1954) particle count with measurement template.

Estimation of Bed-Material Transport Rates Using Established Transport Equations

Application of bed-material transport formulas are a common means of estimating sediment fluxes in streams (Collins and Dunne, 1989; Gomez, 1991; Hicks and Gomez, 2003). A primary advantage of using bedload transport equations is that the approach can be applied on any stream for which information on flow, channel geometry and bed-sediment characteristics is available. Moreover, the application of these formulas is typically straightforward and can provide a relatively rapid means of estimating sediment flux across a range of flow scenarios, from individual storm events to decades. For the Chetco River, we apply multiple transport relations for seven locations between FPkm 15.3 and 2.6 for the nearly 40 years of available flow data, enabling assessment of spatial and temporal trends in bed-material transport.

Although there are several empirical and semiempirical transport equations for bedload transport (Gomez and Church, 1989), all actually predict only the transport capacity, defined as the “maximum load a river can carry” (Gilbert and Murphy, 1914, p. 35). For conditions of unlimited bed material available from the bed and banks, a correct relation for transport capacity coupled with accurate descriptions of flow and bed material should result in accurate estimates of bed-material flux. For the Chetco River, the assumption of unlimited supply is probably approximately valid because of the voluminous gravel accumulations flanking and underlying the valley bottom within the study area and in the 12 km upstream of the study area.

Nonetheless, even if river conditions meet this requirement that bed-material transport is a function of flow, channel, and bed texture rather than sediment availability, large uncertainties still arise because bed-material transport is highly variable in time and governed by highly nonlinear relations between local flow and bed material tranport—both of which are difficult to characterize at high resolution (Gomez, 1991; Wilcock and others, 2009). These challenges, in conjunction with the wide variety of field situations and few measurements, in part explain the large number of transport equations available and the variation in their forms and data requirements (Hicks and Gomez, 2003). For this study, we assess and possibly mitigate for these factors by (1) evaluating multiple transport relations for multiple cross sections, (2) check transport equations against the direct bedload measurements, (3) characterize flow at individual cross sections using the results from a calibrated one-dimensional flow model, and (4) evaluate the results in the context of other information on sediment flux rates.

Equation Selection and Analysis

The bedload transport calculations for the Chetco River were implemented by the software package Bedload Assessment in Gravel-bedded Streams (BAGS), a program operating within a Microsoft Excel workbook (Pitlick and others, 2009). BAGS enables users to select from six semiempirical transport formulas, all of which were developed and tested using data from gravel or sandy-gravel streams (Wilcock and others, 2009). Users specify an equation and geometry, flow, and sediment parameters. With this information, bed-material transport rates are calculated for a specific flow and cross section geometry.

The bedload transport formulas implemented in BAGS are:

- Parker–Klingeman–McLean, a substrate-based equation (Parker and others, 1982)
- Parker–Klingeman, a substrate-based equation (Parker and Klingeman, 1982)

- ☐ Bakke and others, a calibrated equation version of the Parker–Klingeman formula (Bakke and others, 1999)
- ☐ Parker, a surface-based equation (Parker, 1990 a,b)
- ☐ Wilcock, a two-fraction calibrated model for sand and gravel, (Wilcock, 2001)
- ☐ Wilcock and Crowe, a surface based equation (Wilcock and Crowe, 2003)

Although all six formulas are substantively similar and have been successfully applied to gravel-bed rivers, key attributes differentiate the equations, elaborated in Wilcock and others (2009). The substrate-based methods (Parker-Klingeman-McLean and Parker-Klingeman) rely upon grain size data from the bed subsurface, and were developed using data collected by Milhous (1973) at Oak Creek, a small gravel-bed stream in the Oregon Coast Range. There are two surface-based methods; the Parker (1990 a, b) equation was developed from grain-size distributions and transport rates at Oak Creek, whereas the Wilcock and Crowe (2003) equation was developed from flume experiments using varying amounts of sand. The two calibrated equations of Bakke and others (1999) and Wilcock (2001) require measurements of bedload transport in order to calibrate reference shear stress, and thus improve the overall transport estimates. In this study, four of the six bedload equations in BAGS were applied to the Chetco River; the two calibrated models of Bakke and others (1999) and Wilcock (2001) equation were not used because of too few direct bedload measurements for reliable calibration.

For the Chetco River, we first applied the four equations not requiring calibration to a cross section adjacent to the bedload measurement site to enable comparison with the direct bedload measurements collected during winter 2008–09 (fig. 30). Underlying the resulting calculations are the surface and subsurface bed-material size distributions measured near the cross section, channel cross sections from the HEC–RAS model, a range of modeled streamflows and their associated model-calculated energy-slope (S_f) values. Although all four equations overpredict the measured transport value for the higher quality December 28, 2008, 14:00 measurement at a streamflow of 1,120 m^3/s by a factor of 1.7 to 3.8, the Parker (1990a, b) and Wilcock and Crowe (2003) surface-bed-composition equations performed better in closely predicting the transport rate measured for the 290 m^3/s streamflow of February 24, 2009 (fig. 28).

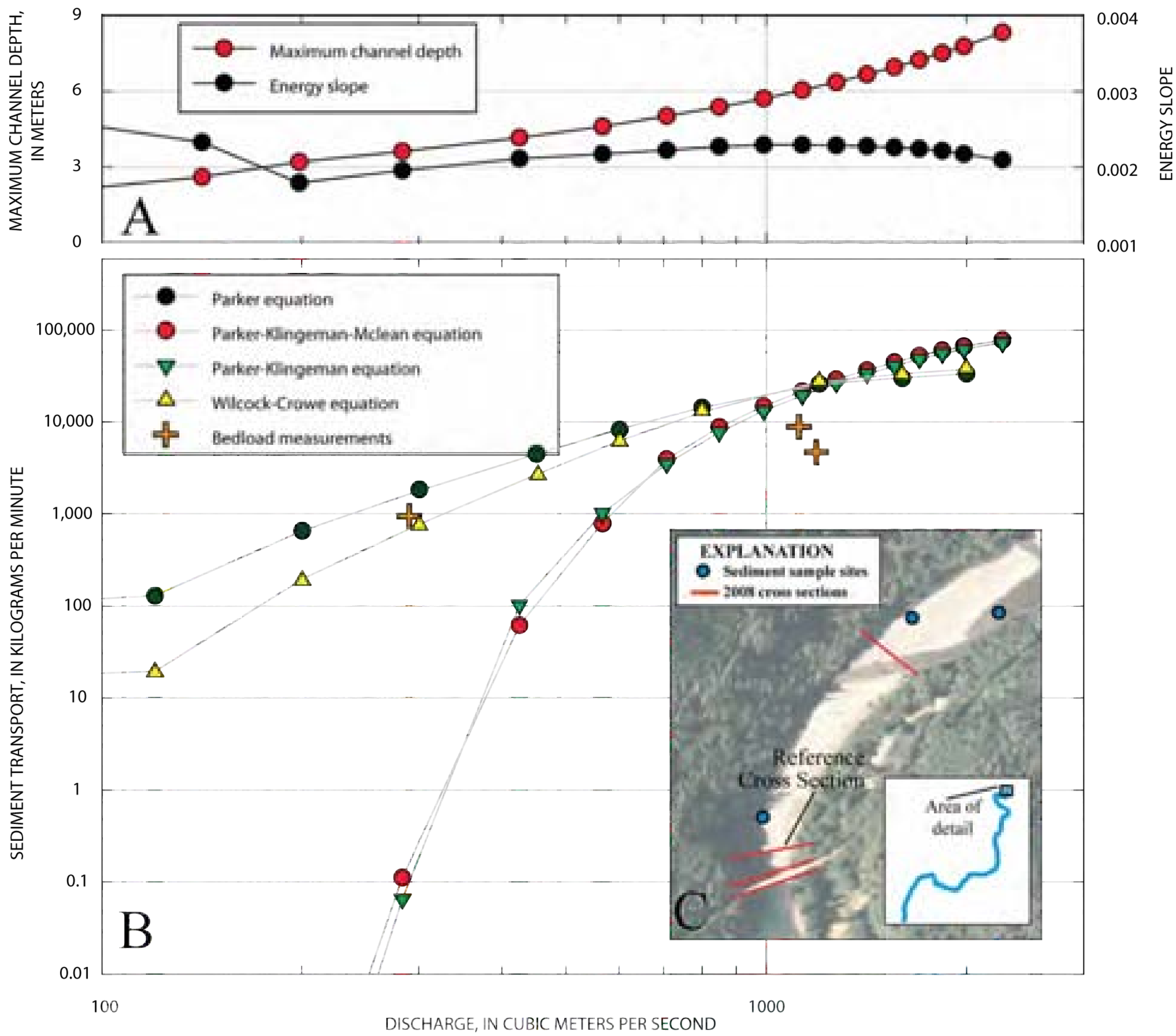


Figure 30. Graphs and map showing streamflow hydraulics, predicted and measured bed-material transport, and location map for vicinity of measurement site near river kilometer 15.3 or the Chetco River, Oregon. A. Modeled flow depth and energy slope for reference cross section at floodplain kilometer 15.3. B. Predicted bed-material transport rates at reference cross section at floodplain kilometer 15.3 for four bed-material transport equations described in text. Also shown are measured bedload transport rates for three measurements made from bridge at floodplain kilometer 15.24. C. Location of streamflow-model cross sections, bed-material transport calculations (reference cross section), the bridge from which the bedload measurements were made (which is also the location of the USGS streamflow gaging station), and location of sediment samples from which grain-size measurements were averaged for calculating bedload transport rates.

The subsequent analysis was carried forward using only the Parker (1990a, b) and Wilcock and Crowe (2003) bed-material transport relations, which have a similar theoretical framework. The major distinction between the two approaches is in determination of the reference Shields shear stress (τ^{*}_{rsg}); in the Parker (1990a, b) equation, τ^{*}_{rsg} is assumed to be a constant value of 0.0386, but in the Wilcock and Crowe (2003) equation, τ^{*}_{rsg} varies with the sand content of the surface bed material.

For each of 7 cross sections between FPkm 2.6 and FPkm 15.3, we calculated transport rates for 12 discharges ranging between 15 and 2,000 m^3/s, using the model-calculated S_f values and nearby measurements of bar-surface particle size (fig. 30, tables 4 and 6). Discharges were increased by 14 percent at the North Fork confluence to account for tributary inflow. The results for each discharge produced a relation between discharge (*Q*) and bed-material transport rate *(Qs*), which were fitted by curves to produce a sediment-discharge rating curve. Although many sediment rating curves are fit by power functions (Hicks and Gomez, 2003; Wilcock and others, 2009), this form did not fully characterize the calculated Chetco River bed-material transport rates. As a consequence, we developed continuous ratings by fitting piecewise polynomial functions to the results for each cross section.

In part, the poor fit of power functions resulted from using the energy slope (S_f) instead of a reach-averaged channel slope. The energy slopes calculated by the step-backwater modeling varied substantially with discharge at nearly all cross sections (fig. 30A), reflecting the transition from channel control on slope (mostly owing to the pool and riffle structure of the low flow channel) to broader valley-bottom controls at higher discharges. Consequently, the transport rating curves were highly variable, especially at low discharges, but approached more typical power functions at higher discharges as S_f approached reach-scale valley slopes (for example fig. 30B).

Partly as a consequence of the nonsystematic variation of S_f with discharge, high transport rates were calculated for some cross sections at very low discharge (commonly where cross sections were located at riffles). In these cases, we assumed no transport at these low discharges. The cutoff discharge ranged from 50 to 230 m^3/s for all but one of the cross sections—flows typically confined to the low flow channel or barely covering low channel-flanking bars and unlikely to transport substantial bed material (fig. 25; Mueller and others, 2005). For the cross section located at FPkm 9.4, no transport was assumed for flows less than 425–450 m^3/s, depending on the transport relation. Very low transport rates calculated for this cross section were likely the result of relatively coarse bed material at the closest sample location, coupled with low calculated energy gradients (table 6).

The resulting $Q–Q_s$ relations served as a basis for calculating annual sediment transport fluxes and their spatial and temporal variation. Annual transport volumes were calculated for each cross section by applying the October 1, 1969–September 30, 2008, discharge record from the USGS streamflow measurement station at FPkm 15.3. Typically, this is done with the mean daily values (for example, Collins and Dunne, 1989) but because of the combination of the highly nonlinear transport rates and the rapid flow changes on the Chetco River during transport events, annual bed-material transport volumes determined from mean daily values are likely to underestimate true values. In consideration of this, we based annual bed-material transport volumes on the higher resolution unit discharge values. For the Chetco River, unit flow values have been recorded at 15-minute intervals since 2006 and at 30-minute intervals prior, but are only electronically archived for the post-1988 period.

Table 6. Summary of calculated transport rates for the Chetco River, Oregon

[Abbreviations: d16, 16th percentile; d50, 50th percentile; d84, 84th percentile; mm, millimeter; kg/s, kilograms per second; Rkm, river kilometer; FPkm, floodplain kilometer; m3/s, cubic meters per second]

Cross Section Location (Rkm)	Cross Section Location (FPkm)	d16 (mm)	d50 (mm)	d84 (mm)	%<2mm (%)	Distance to surface sample site (m)	*Equation*	Low-flow cut- off (m3/s)	Energy slope (50 m3/s)	Trans-port rate, kg/s (50 m3/s)	Energy slope (100 m3/s)	Trans-port rate, kg/s (100 m3/s)	Energy slope (500 m3/s)	Trans-port rate, kg/s (500 m3/s)	Energy slope (1000 m3/s)	Trans-port rate, kg/s (1000 m3/s)	Energy slope (2000 m3/s)	Trans-port rate, kg/s (2000 m3/s)	Mean annual trans-port, 1970–2008 (m3/yr)
16.9	15.3	12.76	38.64	82.80	3.7	250	Parker	150	0.333%	0.246	0.245%	0.293	0.214%	60	0.229%	305	0.217%	568	51,100
							Wilcock-Crowe	50		1.414		1.883		89		306		509	73,900
16.5	14.9	11.86	28.87	57.42	0.0	250	Parker	100	0.035%	0.000	0.060%	1.364	0.180%	98	0.180%	270	0.170%	793	103,200
							Wilcock-Crowe	100		0.000		0.660		47		113		324	54,300
14.6	13.3	18.64	37.15	63.07	1.0	270	Parker	100	0.119%	0.001	0.161%	10.436	0.211%	38	0.183%	167	0.161%	600	79,100
							Wilcock-Crowe	100		0.009		5.630		21		84		278	43,600
12.6	11.5	11.00	36.33	72.13	3.5	180	Parker	230	0.053%	0.000	0.066%	0.000	0.179%	118	0.243%	485	0.248%	789	83,000
							Wilcock-Crowe	170		0.000		0.053		136		444		663	91,100
9.4	8.5	21.78	53.26	89.40	1.0	850	Parker	450	0.036%	0.000	0.059%	0.000	0.143%	4	0.171%	30	0.119%	3	5,700
							Wilcock-Crowe	425		0.000		0.000		4		23		5	4,100
6.0	5.3	10.40	19.75	37.96	3.0	20	Parker	110	0.152%	0.004	0.155%	0.116	0.086%	10	0.083%	78	0.084%	326	9,600
							Wilcock-Crowe	110		0.108		0.673		11		56		189	10,100
3.1	2.6	2.50	11.93	30.10	12.0	240	Parker	230	0.027%	0.000	0.040%	0.000	0.049%	2	0.051%	38	0.063%	310	3,900
							Wilcock-Crowe	100		0.101		0.548		16		99		402	15,100

For the 1988 through 2008 water years, we calculated transport rates for each cross section using the 15-min and 30-min unit flow data, summing total transport for each day. To extend the record back through water year 1970 and to fill more recent periods when unit flow data was not available (unit flow data are not available for all of 1993 and parts of several other years), we developed relations for each cross section between daily transport volumes calculated from the unit flow measurements and mean daily flow for all days of predicted transport. These regressions, which had regression correlation coefficients ranging from 0.968 to 0.998, were applied to all days so to permit calculations for the entire October 1, 1969–September 30, 2008, record.

Results and Discussion of Bed-Material Transport Equation Calculations

Application of the Parker (1990a, b) and Wilcock and Crowe (2003) bed-material transport equations for seven cross sections over 39 years indicates considerable spatial and temporal variability in predicted annual transport volumes (figs. 31 and 32). On the basis of the overall consistency in predicted transport capacity for the cross sections in the Upper and Emily Creek reaches (fig. 31) and the agreement between measured and predicted transport rates (fig. 30), we judge the results for the cross section at FPkm 15.3 to be representative of the volume of bed material entering the study reach. For this “reference” cross section (fig. 30C), predictions of bed-material influx into the reach range from less than 3,000 m^3/yr for some very dry years such as 1977 and 2001, to more than 150,000 m^3/yr for the wet years of 1982 and 1997 (fig. 32). The mean annual volume for the 1970–2008 period for this cross section is 51,100 m^3/yr as calculated by the Parker (1990 a, b) relation, and 73,900 m^3/yr based on the Wilcock and Crowe (2003) equation (table 6). These values are closely bracketed by 43,600–103,200 m^3/yr range encompassed by the predictions of mean annual transport for all four of the analyzed cross sections in the Upper and Emily Creek reaches.

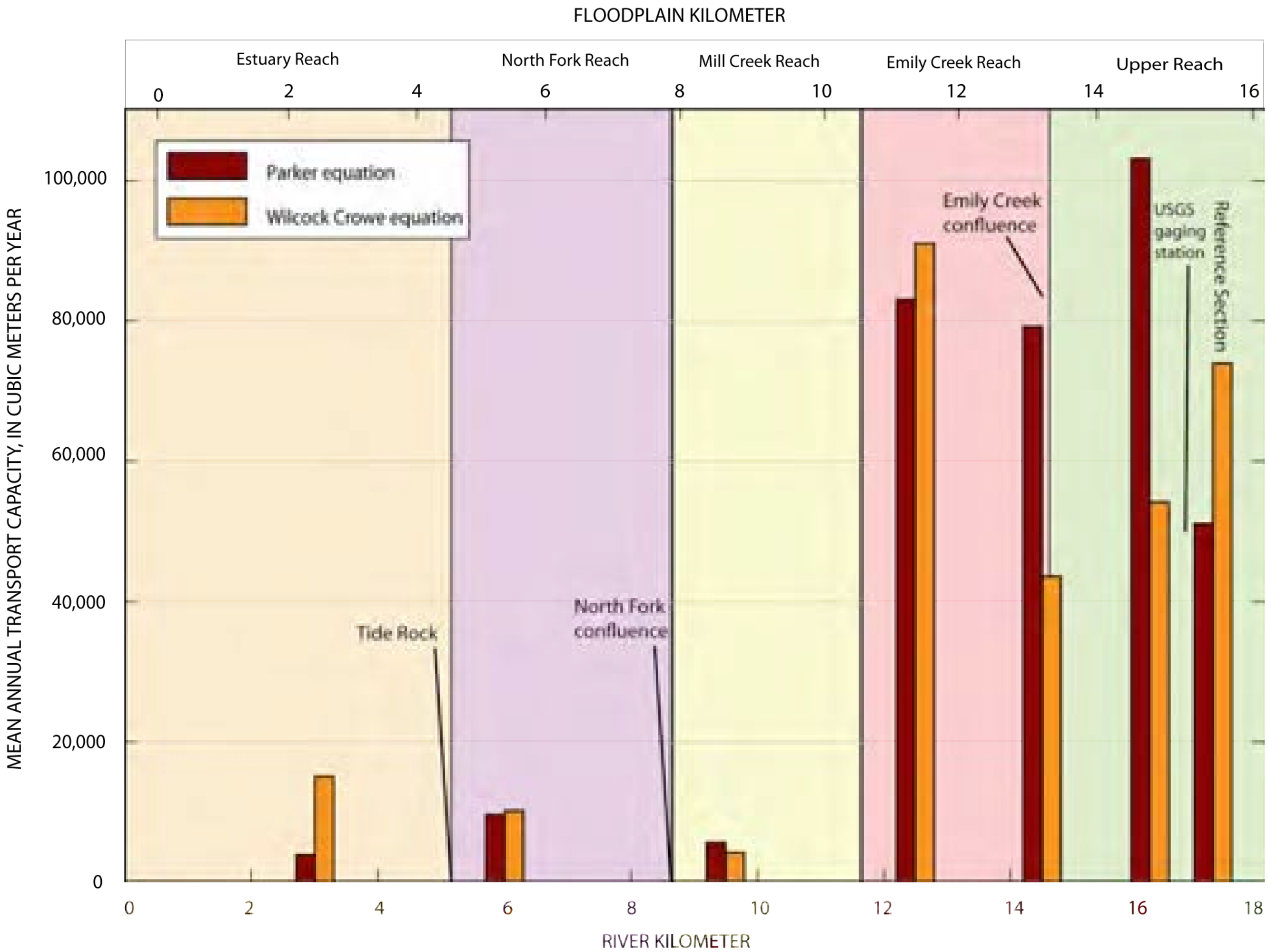


Figure 31. Graph showing mean annual predicted bed-material transport capacity for seven cross sections along the lower Chetco River, Oregon, for water years 1970–2008. Calculations based on Parker (1990, a, b) and Wilcock and Crowe (2003) transport equations. Hydraulics at each cross section from one-dimensional step-backwater hydraulic model for entire study reach.

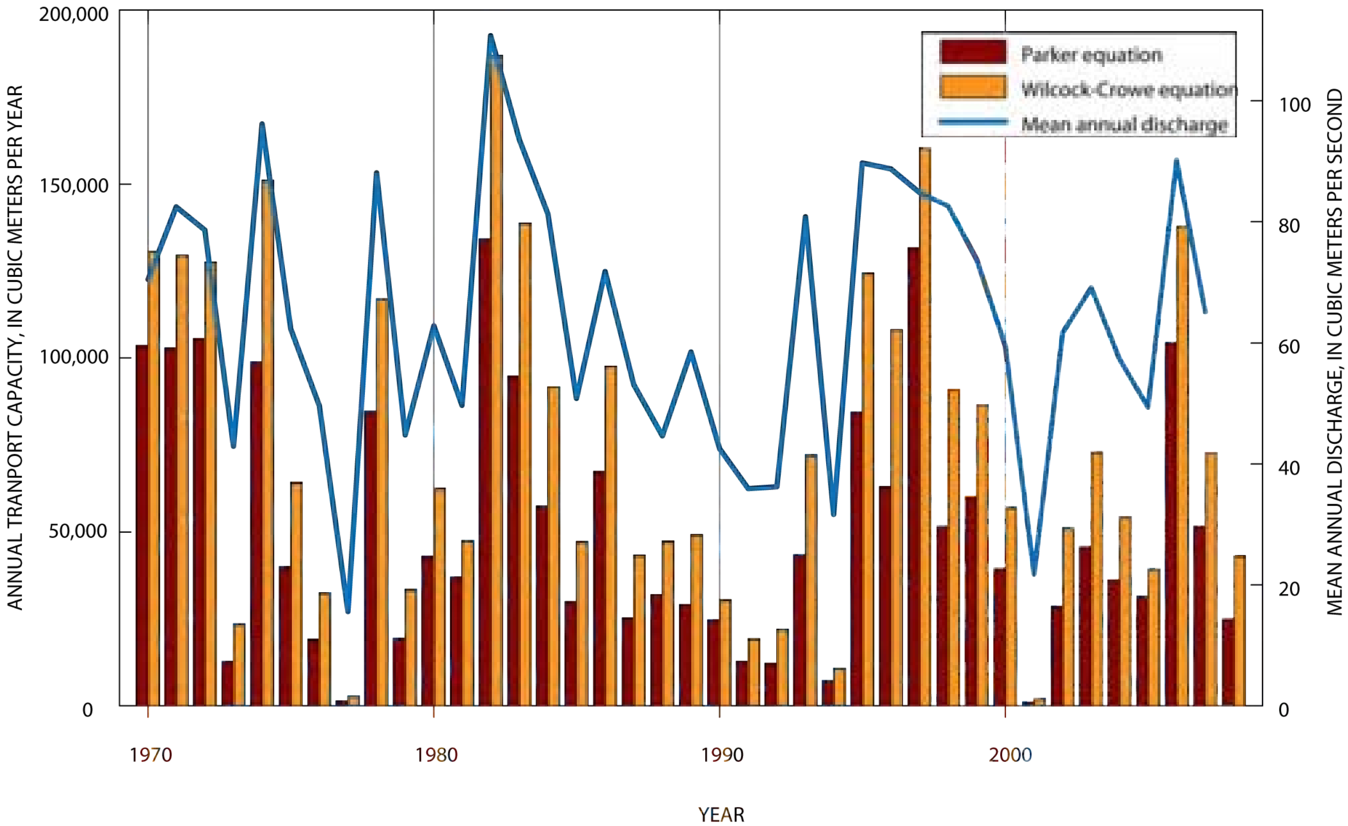


Figure 32. Graph showing mean annual discharge from USGS streamflow gaging station Chetco River near Brookings, Oregon (14400000). Annual bed-material transport capacity computed for reference cross section at floodplain kilometer 15.3 for water years 1970–2008 on basis of the Parker (1990 a, b) and Wilcock and Crowe (2003) transport relations.

For each of the seven analyzed cross sections, the predicted range of annual bed material transport averaged over the 39-year analysis period ranges from 3,900 m^3/yr at FPkm 2.6 to 103,200 m^3/yr at FPkm 14.9 for the Parker (1990 a, b) equation, and 4,100 m^3/yr at FPkm 8.5 to 91,100 m^3/yr at FPkm 11.5 for the Wilcock and Crowe (2003) equation (fig. 32). The section-to-section spatial variability of mean annual transport rates along the channel is probably not indicative of actual conditions because of (1) differences in the suitability of particular cross sections for bed-material transport calculations because of factors such as flow obstructions and along cross section variations in shear stress, (2) poor characterization of local surface particle size distributions, particularly since some analyzed cross sections were up to 850 m away from the nearest sediment sampling location, and (3) differences in the accuracy of the hydraulic modeling for each cross section, particularly in regards to calculated values of S_f, which is a critical flow parameter controlling transport rates (Wilcock and others, 2009). Nevertheless, the general trends evident in figure 32—transport capacities of 40,000 to 100,000 m^3/yr in the Upper and Emily Creek Reaches, diminishing downstream to less than 10,000 m^3/yr in the Mill Creek Reach—probably closely indicate overall transport conditions. As described subsequently, this pattern is also consistent with geomorphic evidence of historical sedimentation in the lower Mill Creek and North Fork reaches.

The annual variability in predicted bed-material transport capacity is also high (fig. 32), but this is attributable to the nonlinear relation between bed material transport and flow coupled with the high year-to-year flow variability. For the reference cross section at FPkm 15.3, the annual calculated bed-material volumes range from 1,067 m^3/yr in the very dry year of 2001, as calculated by the Parker (1990 a, b) relation to 160,500 m^3/yr in water year 1997, as calculated by the Wilcock and Crowe (2003) equation. The distribution of predicted annual transport volumes is negatively skewed, meaning that the majority of years—about 60 percent—have transport rates less than the mean value. The 2002 water year record highlights the temporal variability within a single year; for this year the total bed-material transport predicted by the Parker (1990 a, b) equation is 28,600 m^3/s, but half of this volume is predicted to have been transported in a 6-day period encompassing less than 2 percent of the year (fig. 33).

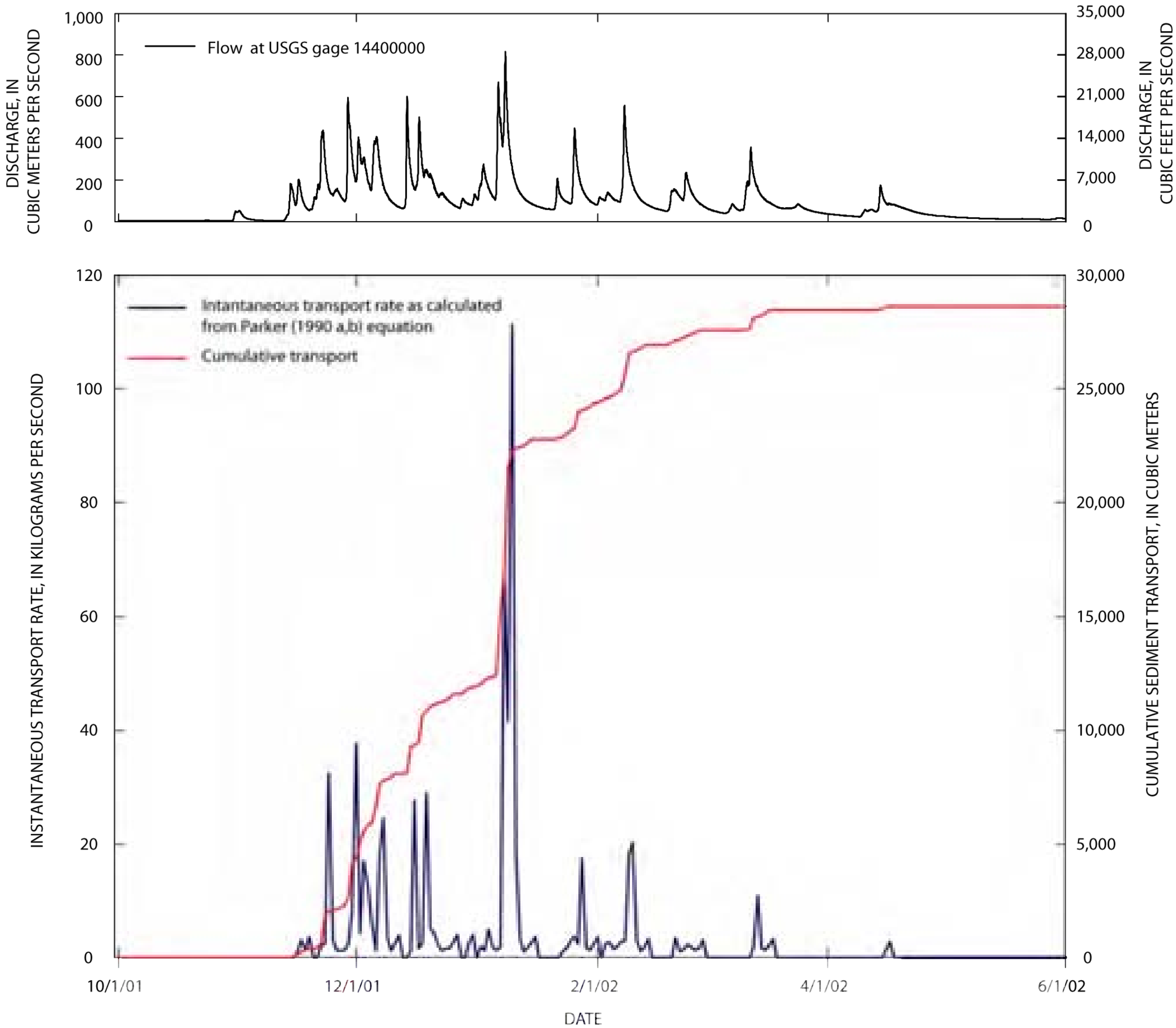


Figure 33. Graphs showing calculated bed-material transport for water year 2002 at reference cross section at floodplain kilometer 15.3, Chetco River, Oregon.

In general, the Parker (1990 a, b) and Wilcock and Crowe (2003) relations produce total annual volume estimates that agree to within a factor of 2 for most analyzed cross sections. Differences in predicted transport capacities between the two equations chiefly owe to the sand content of the surface bed material, with the Wilcock and Crowe (2003) relation predicting higher transport rates at cross sections where the sand content is higher, such as for the downstream-most site at FPkm 2.6. For cross sections where the surface samples had little sand, such as those at FPkm 11.5, 8.5, and 5.4, the equations agree to within 10 percent (table 6).

Quantitative assessment of the uncertainty of the transport values derived from application of these bed-material capacity equations is challenging, especially for situations of few actual measurements (Pitlick and others, 2009). The two direct bedload discharge measurements support selection of the Wilcock and Crowe (2003) and Parker (1990a, b) equations for calculating transport capacity, as well as the underlying assumption that bed-material transport is indeed a function of streamflow rather than supply. Measurements are lacking, however, to test these equations and assumptions for elsewhere in the study reach. Beyond uncertainty owing to the semiempirical nature of the equations, uncertainty and errors arise from channel geometry, flow and sediment texture characterizations. A range of these parameters are embodied, however, in calculated transport rates for each of the cross sections, and the resulting range of mean annual transport volume of 51,120–103,200 m^3/yr (as calculated by the Parker equation (1990 a, b)) for the four cross sections in the Upper and Emily Creek reaches transport relation provides an indication of the effects of such uncertainty owing to characterization of local conditions. Systematic analysis of the effects surface bed-material size on calculated transport rates for the reference cross section at FPkm 15.3 shows that a ± 10 percent variation in the surface grain size distribution results in 20–35 percent difference in predicted transport rates, indicating that transport capacity is highly sensitive to surface bed-sediment texture.

One independent check of the overall reasonableness of these predicted values is consideration of the predicted transport volumes relative to bar area. For water year 2005, the Parker (1990 a, b) and Wilcock and Crowe (2003) equations applied to the reference cross section predict 31,500 and 39,500 m^3 entering the study area, respectively, volumes that translate to seemingly reasonable values of 15–20 cm of deposition on all the bare bars (which generally correspond to the low elevation bar surfaces) as mapped in the study reach from aerial photographs taken in the summer of 2005.

The primary means by which uncertainty in the transport equations could be reduced is by more direct bedload measurements. Additional measurements would allow additional checking of the equations used in this analysis or enabling use of the calibrated transport equations of Bakke and others (1999) and Wilcock (2001). If a sufficient number of measurements were available over a wide range of flows, a site-specific empirical equation relating bed-material transport to flow could supplant the application of the equations and allow for more rigorous assessments of uncertainty.

Estimation of Bed-Material Flux by Assessment of Channel Change

An independent approach to assessing the transport rates of bed material is to exploit the intrinsic relation between rates of channel change in alluvial rivers and rates of sediment transport. This type of “morphology-based” based approach (Popov, 1962; Martin and Church, 1995) relates volumetric change within a reach to assumptions regarding storage, annual transport lengths, or independent boundary conditions to provide annual estimates of bed-material flux. Morphology-based approaches to estimating sediment budgets have been applied to numerous gravel-bed rivers throughout the world, including many rivers in similar environments as the Chetco River (Collins and Dunne, 1989; Martin and Church, 1995; McLean and Church, 1999; Ham and Church, 2000; Gaueman and others, 2003; Martin and Ham, 2005; Surian and Cisotto, 2007). In proper settings, this approach has the advantage of (1) being based on actual measurements of observed channel change, (2) being potentially applied for multiple time periods and in the absence of flow data, and (3) integrating multiple transport events in determining bed-material fluxes, thereby avoiding the uncertainties in predicting transport from applying strongly nonlinear transport relations to highly variable flows.

Morphologic Analysis

Estimates of bed-material transport rates require volumetric estimates of changes in bed material for specific time periods. For the Chetco River, most bed material is stored in the bars flanking the low-flow channel, so this analysis focused on estimating changes in bar volume. Estimates of volumetric change are best acquired from repeat high-resolution topographic surveys (Martin and Church, 1995; McLean and Church, 1999) but in the absence of such surveys, they are commonly obtained by mapping planview changes between sequential sets of aerial photographs and estimating the thickness of bed material involved in the mapped changes (Collins and Dunne, 1989; Gaueman and others, 2003). Short analysis periods are preferable to reduce the negative bias in calculated volumetric change introduced by possible repeated erosion and deposition at the same location by multiple events. Consequently, the ideal situation is to calculate volumetric changes after each transporting flow (Lindsay and Ashmore, 2002), but the more typical circumstance is to rely upon aerial photograph sequences spanning periods of less than 5 years. A potentially favorable situation for future analyses made possible recently is the opportunity to accurately determine volumetric changes by repeat LIDAR surveys using the survey in 2008 as a starting point.

For the Chetco River study area, we applied this approach using sequences of aerial photographs and the LIDAR survey of 2008, which together span five time intervals: 1939–1943, 1962–1965, 1995–2000, 2000–2005, and 2005–2008. This analysis was based on the maps of the active channel areas described previously. For each time period, we overlaid the maps of active channel features to create three polygon classes (fig. 34): "Erosion," "Deposition" or "No Volumetric Change." Erosion polygons were assigned to areas where a bar or floodplain feature mapped on the first photograph set became a water feature on the second photograph set of the analysis pair. Likewise, "Deposition" polygons were those that changed from water to bar (in cases water became floodplain). Areas that did not change between land and water were classified as "No Volumetric Change."

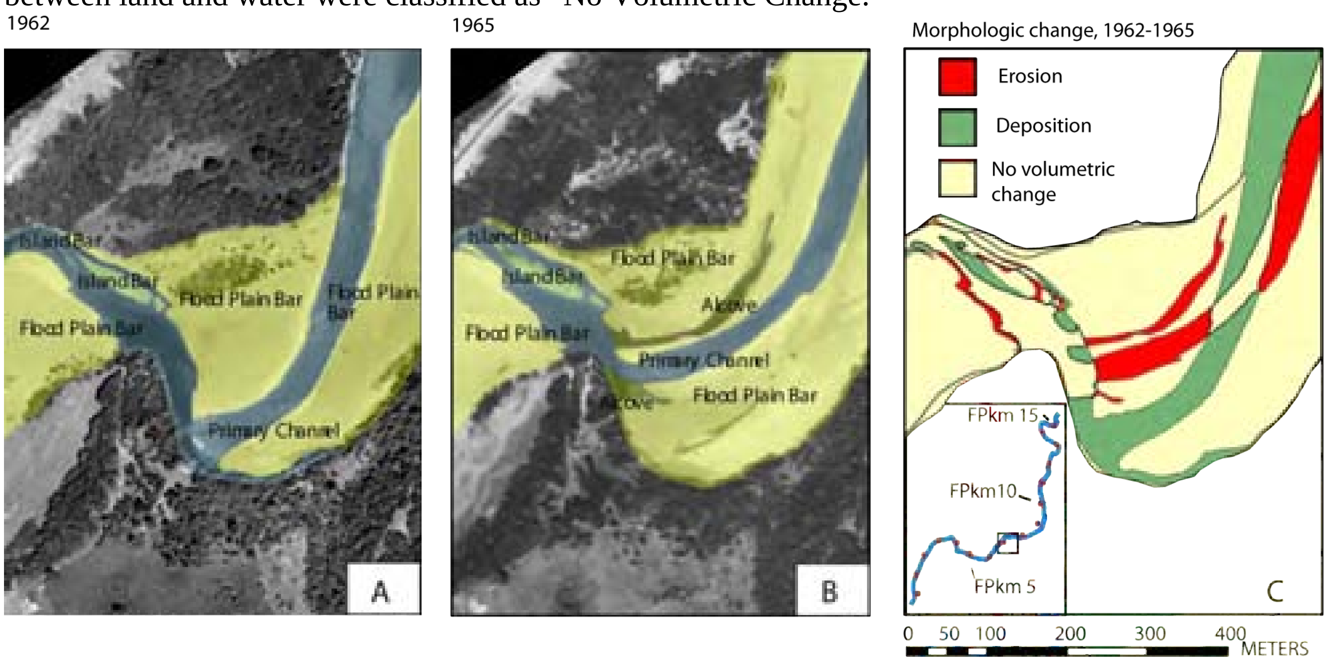


Figure 34. Maps showing example of erosion and deposition classification for morphologic analysis near floodplain kilometer 7, Chetco River, Oregon. A. 1962 Channel and bar mapping. B. 1965 Channel and bar mapping.
C. 1962–65 erosion, deposition, and no-change classifications. FPkm, floodplain kilometer.

Because this approach relies on the accurate mapping of depositional and erosional areas, several steps were taken to reduce mapping errors and georeferencing and rectification uncertainties. These steps included reclassifying some features on the active-channel maps to avert erroneous designations and transitions, such as classifying small disconnected water bodies as “Deposition” because they were water filled on one photograph but dry on the next. We also eliminated all very small areas (mostly less than 10 m^2 but as large as 200 m^2) that possibly resulted from imprecise registration or digitization of features that had not seemingly changed. These areas, however, cumulatively represent only a very small percentage of the total depositional and erosional areas; for example, for the period between 1939 and 1943, the total area excluded by these uncertain polygons was less than 2 percent of total area of change. Each of the polygons remaining after this process was inspected at 1:3,000 to verify assigned classifications.

As for the assessment of temporal trends in bar area, different discharges (and stages) between photo sets in analysis pairs were accounted for by adjusting the net area of erosion or deposition by the estimated difference in bar area owing to the difference in discharge (fig. 7). For certain year pairs, such as 2005 and 2008, for which the difference in discharge is small, this adjustment is very small. But for analysis periods such as 1939–43 and 1995–2000, this adjustment is large relative to the area of net erosion or deposition (fig. 35, table 7).

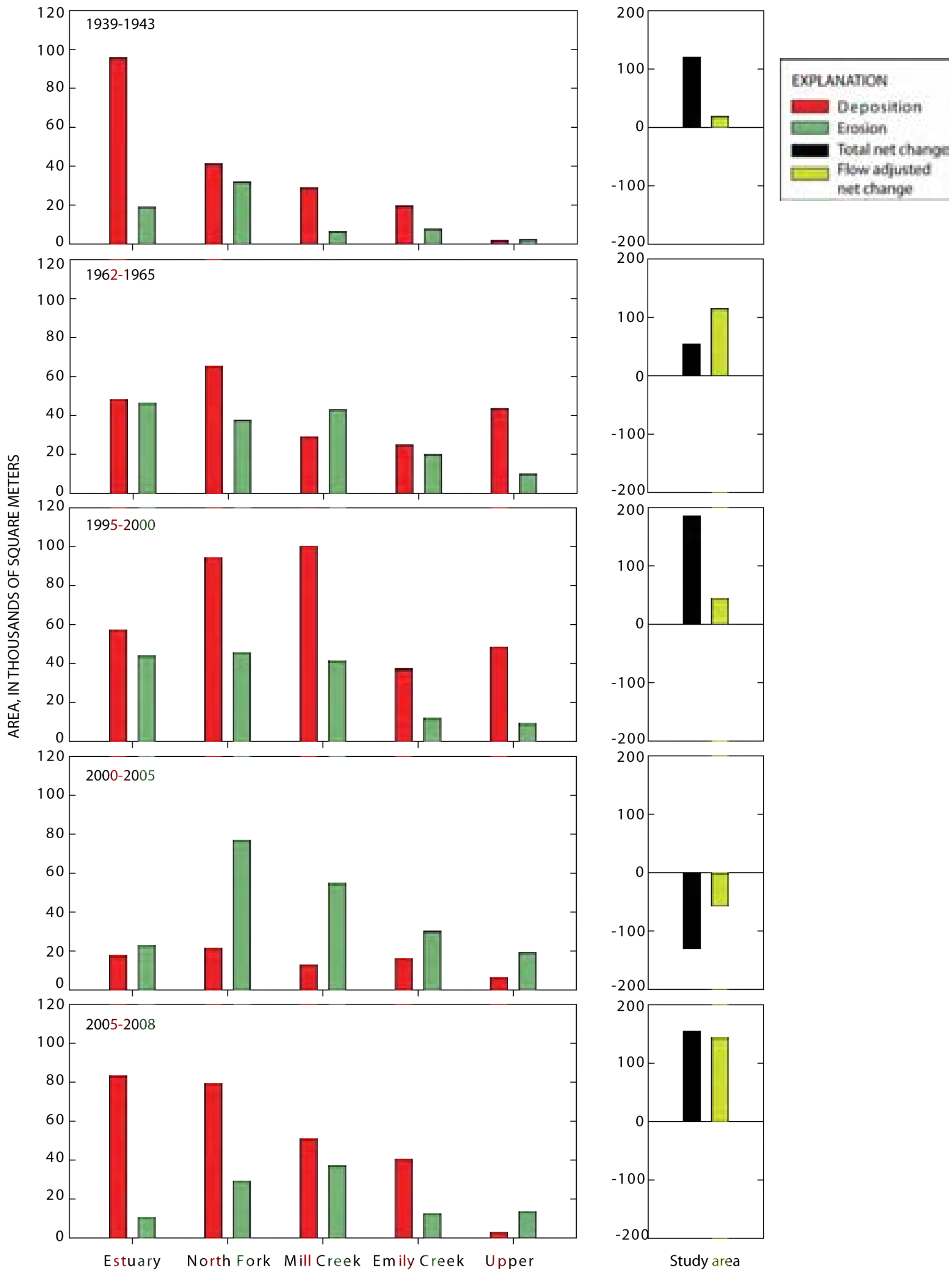


Figure 35. Graphs showing areas of bed-material erosion and deposition volumes for selected time periods in the Chetco River, Oregon. Individual reach measurements not adjusted for difference in flow stage. For each time period, however, the total net change for the study reach was adjusted for flow

difference between photo sets
(fig. 7) to determine "flow-adjusted net change" to use in calculating net bed-material influx to the study reach.

Table 7. Summary of morphology-based sediment-transport-volume estimates for the Chetco River, Oregon—continued

[Abbrev uare meters; m^3, cubic meters; --, no data]

	Period				
	1939–1943	**1962–1965**	**1995–2000**	**2000–2005**	**2005–2008**
Period length (years)	4	3	5	5	3
Area of eroded bar (m^2)	67,000	157,000	152,000	204,000	102,000
New bar area (m^2)	187,000	211,000	337,000	74,000	257,000
Net measured change in bar area (m^2)	120,000	54,000	185,000	-130,000	155,000
Flow-adjusted change in bar area (m^2)	19,000	115,000	44,000	-57,000	144,000
Scenario 1: Erosion and deposition, where bar height in each reach is average of all bars					
Volume of erosion (m^3)	183,000	443,000	421,000	560,000	283,000
Volume of deposition (m^3)	538,000	598,000	942,000	214,000	723,000
Net change in bed material (m^3)	355,000	155,000	521,000	-346,000	440,000
Flow-adjusted net change in bed material (m^3)	42,000	333,000	100,000	-150,000	411,000
Annual net balance [3](m^3/yr)	89,000	52,000	104,000	-69,000	147,000
Flow-adjusted annual net balance [3](m^3/yr)	11,000	111,000	25,000	-30,000	137,000
Scenario 2: Erosion and deposition, where bar height in each reach is average of all low bars					
Volume of erosion (m^3)	116,000	282,000	268,000	338,000	171,000
Volume of deposition (m^3)	361,000	375,000	581,000	133,000	462,000
Net change in bed material (m^3)	245,000	93,000	313,000	-205,000	291,000
Flow-adjusted net change in bed material (m^3)	56,000	204,000	75,000	-85,000	273,000
Annual net balance [3](m^3/yr)	61,000	31,000	63,000	-41,000	97,000
Flow-adjusted annual net balance [3](m^3/yr)	14,000	68,000	15,000	-17,000	91,000
Scenario 3: Erosion calculated using reach average height of all bars; Deposition calculated using reach average height of low bars					
Volume erosion	183,000	443,000	421,000	560,000	283,000
Volume of deposition	361,000	375,000	581,000	133,000	462,000
Net change in bed material (m^3)	178,000	-68,000	160,000	-427,000	179,000
Flow-adjusted net change in bed material (m^3)	-48,000	81,000	-145,000	-245,000	153,000
Annual net balance [3](m^3/yr)	44,000	-22,000	32,000	-85,000	59,000
Flow-adjusted annual net balance[3] (m^3/yr)	-12,000	27,000	-29,000	-49,000	51,000
Summary Ranges: Flow-adjusted annual net balances (m^3)	-12,000 to 14,000	-27,000 to 111,000	-29,000 to 25,000	-49,000 to -17,000	51,000 to 137,000

Table 7. Summary of morphology-based sediment-transport-volume estimates for the Chetco River, Oregon—continued

[Abbreviations: m^2, square meters; m^3, cubic meters; --, no data]

	Period				
	1939–1943	1962–1965	1995–2000	2000–2005	2005–2008
Summary Comparisons					
Total volume (m^3) removed due to gravel mining[1]	--	--	160,000	310,000	185,000
Total bed-material (m^3) influx as predicted by transport equations[2]	--	--	390,000 to 530,000	190,000 to 270,000	200,000 to 270,000
Total bed-material (m^3) influx as predicted by morphologic approach (flow-adjusted) and accounting for gravel extraction volumes[4]	--	--	15,000 to 260,000	65,000 to 225,000	338,000 to 596,000
Average annual lower Chetco River influx from bedload transport equations [5](m^3/yr)	--	--	78,000 to 106,000	38,000 to 54,000	67,000 to 90,000
Annual lower Chetco River bed-material influx as calculated from range of flow-adjusted morphologic estimates and accounting for gravel extraction volumes, and assuming no bed-material transport out the lower river (m^3/yr)	[6]-12,000 to 14,000	[6]-27,000 to 111,000	3,000 to 52,000	13,000 to 45,000	113,000 to 197,000

1. Gravel mining volumes were provided by operators (fig. 6), and in some cases are estimated. Total volume of extraction for each period only includes extraction bracketed by the dates of the photographs used in the mapping; for example, the mined volume for 1995–2000 includes extraction from 1995, 1996, 1997, and 1999

2. The sediment influx was calculated using the equations of Wilcock and Crowe (2003) and Parker (1990 a, b). Totals reported here assume no sediment transport the latter part of the water year (July-September) and were calculated by summing transport for each of the water years bracketed by the mapping periods. For example, the sediment load for 1995-2000 includes transport from the 1996, 1997, 1998, 1999, and 2000 water years, but assumes no transport for the latter part of 1995 post-dating the May 27 date of the 1995 aerial photographs.

3. The annualized net balance was computed by dividing the difference between deposition and erosion by the number of years in the period.

4. The ranges reflect all three bar-thickness scenarios

5. Annual fluxes calculated by dividing period totals by the number of years in the analysis period; range encompasses different predictions by the Wilcock and Crowe (2002) and Parker (1990 a, b) equations for each period.

6. Assumes negligable gravel extraction, therefore probably underestimates true influx values.

More difficult to infer from the aerial photograph pairs is the thickness of bed material involved in areas of erosion and deposition, a critical parameter for estimating volumes. The approach used was to designate characteristic bar thicknesses for each reach, which were then multiplied by erosional and depositional areas to obtain corresponding volumes. An upper limit for characteristic bar thickness was determined from measurements of average bar elevation above the channel thalweg, measured by GIS analysis of the channel and LIDAR topographic measurements for 543 orthogonals spaced at 30-m intervals along the channel centerline and stratified by reach (fig. 36). Calculated in this manner, average bar height in 2008 ranged from 2.4 m in the North Fork Reach to 3.7 m for the Emily Creek Reach.

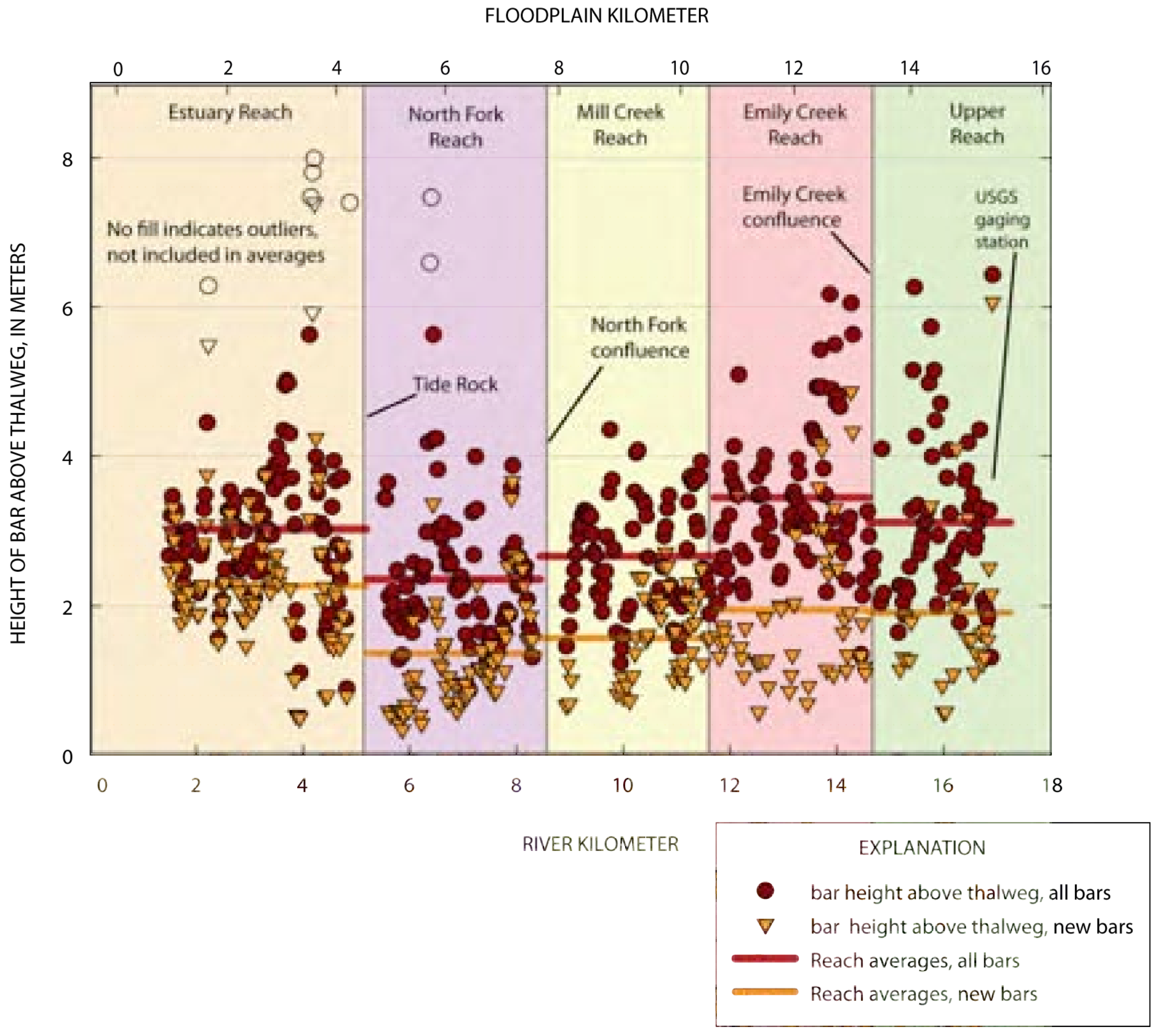


Figure 36. Graph showing bar thickness values used to calculate erosion and deposition volumes from changes in bar area in the Chetco River, Oregon. Values determined by difference of average bar elevation and thalweg elevation at 30-m intervals along the floodplain centerline, and averaged for each reach. "All bars" include all bars mapped from 2008 LIDAR. "New bars" are bars that formed between 2005 and 2008, are typically lower, and are inferred to more closely represent the thickness of new deposits.

To determine a lower bound, and one that probably better reflects deposit thickness for newly formed bars, we used the same analysis but evaluated elevations only from bars created between 2005 and 2008 (fig. 36), resulting in estimates of "new bar" average thicknesses between 1.5 and 2.3 m (relative to thalweg) depending on reach. Implicit in using these new-bar values for earlier analysis periods is that the relation between channel thalweg elevation and bar height is similar for all time periods. As we have shown from the channel change analysis, however, this assumption is probably not valid for certain periods, and the channel lowering since the late 1970s (without substantial coincident bar lowering) may result in volume overestimates for earlier time periods, especially for the periods 1939–43 and 1962–65, which predate channel incision. Also difficult to infer from aerial photographs is the thickness of deposition or scour on surfaces not changing status during an observation period, including gravel bars and areas within the low-flow channel. These volumes are not considered by our analysis, but could be evaluated in future analyses with additional LIDAR or high resolution topographic surveys.

Assessment of Sediment Volumes from Morphologic Analysis

On the basis of three depositional and erosional thickness scenarios, we calculated areas and volumes of erosion and deposition for each of the five time periods and for each of the five reaches, using three scenarios for erosional and depositional thickness (fig. 35, table 7). The three scenarios involved multiplying the areas of erosion and deposition by (1) reach-average values for average bar thickness, (2) reach-average values for average new-bar thickness, and (3) what we judge as the most realistic scenario of calculating erosional volumes by multiplying the area of erosion by the average thickness of all bars but using the average thickness of the new bars for calculating depositional volumes. This latter scenario is certainly most appropriate for the 2005–08 analysis period, because the value for the average thickness of new bars was obtained specifically for this time period. Evident from this analysis is that for all scenarios, measured deposition and erosion areas and volumes as determined from changes in bar area are larger in the downstream reaches (fig 35, table 7). Also evident is that for most time periods and reaches, this measurement approach shows more deposition than erosion. The periods of greatest positive net change, after accounting for differences in flow, were the 1962–65 and 2005–08 periods, both spanning exceptional floods. The relatively dry 2000–05 period is the only one for which every reach apparently lost bed-material volume, even after accounting for the higher flow on the 2005 aerial photographs.

Estimating actual transport rates requires additional assumptions. The simplest situation and the one applied here is to assume no gravel transport from the river to the ocean, and to consider the net changes to represent bed-material influx rates for the entire lower Chetco River. This approach has been applied to several of the British Columbia studies, in which bed material fines downstream and the channels transition from gravel to sand bed (Martin and Church, 1995; McLean and Church, 1999; Ham and Church, 2000). This assumption may not apply perfectly here because of the historical presence of isolated gravel bars downstream to FPkm 1. Nevertheless, the few bars in the lower 3 km, the downstream reduction in bed-material grain size (fig. 22), and the 80- to 90–percent decrease in transport capacity (fig. 31) predicted by the transport equations for conditions in 2008 indicate that the flux of gravel-size bed material exiting the study reach is a very small fraction of that coming in. Accordingly, the net volume accumulated in the study reach is a minimum indication of bed-material flux at the upstream end of the study reach. A more complete assessment includes the volume removed by gravel extraction (Martin and Church, 1995), thereby implicitly assuming that the mining volumes have been replenished without significantly affecting bar and channel boundaries. This assumption is approximately correct for the Chetco River where recent gravel extraction has been by bar skimming at locations away from the low channel, and that repeat surveys show substantial replenishment most years (Ted Freeman, Freeman Rock Inc. and Robert Elayer, Tidewater Contractors Inc., written commun., 2008). Therefore, for the summary calculation of lower Chetco River bed-material influx from the morphologic approach, we have added the reported volumes of mined gravel for the 1995–2000, 2000–05, and 2005–08 periods (table 7).

Total volumetric changes and flux estimates are best assessed for the more recent periods for which thickness estimates are most valid and for when we have the most reliable estimates of the volume of gravel extracted by mining. For the period 2005–08, the total calculated net volume change ranges from 179,000 to 440,000 m^3 for the three thickness scenarios (table 7). The low end of this range is from our preferred scenario of using average thickness of all bars to calculate erosional volumes but only the thickness of new bars to determine depositional volumes, and gives an annual net volume of 59,000 m^3/yr. Adjusting this value for the difference in discharge in the source imagery for the 2005 and 2008 mapping lowers the average bed-material sediment balance to about 51,000 m^3/yr. Accounting for the 62,000 m^3/yr removed by gravel mining during 2005–07 (the LIDAR of 2008 was acquired before that year's gravel mining) results in an estimated total gravel influx into the lower Chetco River of 113,000 m^3/yr for the 2005–8 analysis period. This value is probably best considered a minimum value as a consequence of (1) the negative biases inherent in the method, especially for periods spanning multiple transport events (Martin and Church, 1995), (2) the assumption that little bed material leaves the river, and (3) our choice of a thickness scenario that minimizes positive volumes; although incomplete replenishment of mined areas would bias this value positively. Similar calculations for the other two analysis periods with gravel extraction data indicate annual bed-material influxes ranging from 3,000 m^3/yr during 1995–2000 to the 32,000 m^3/yr measured for 2000–05. For the earlier periods for which there is no reliable gravel extraction information, annual influx rates considering only the changes in bar area are small for 1939–43 (-12,000 to 14,000 m^3/yr) and possibly large for 1962–65 (-27,000 to 111,000 m^3/yr), but the wide range resulting from the various thickness scenarios and the undetermined volume of removed gravel makes these values highly uncertain.

The high influx values for 2005–08 compared to the lower values calculated for the period 2000–05 correspond with overall high and low flow for those periods (fig. 2). In addition, the values of annual influx, considering the range of thickness scenarios, correspond within a factor of 3 to those predicted by the bedload transport equations for these two time periods. For the period 1995–2000, however, the morphologic method predicts substantially smaller influxes than the transport equations.

The spatial variations in areas of erosion and deposition are consistent with the overall geomorphology (fig. 35). The Upper Reach has had only small net changes in sediment accumulation volumes, and this narrow section apparently has little dynamic storage. We infer that the gravel bars within this reach have morphologies in approximate equilibrium between deposition and erosion, with entrainment approximately balanced by deposition during each transporting flow. More dynamic storage has been accommodated by the wider and lower gradient reaches downstream, particularly the Mill Creek, North Fork, and Estuary Reaches. For the Estuary Reach in particular, the analysis periods have been ones of bar growth, although this is counter to the overall trend for this reach during the entire historical period (figs. 9 and 10).

Although this method as applied here shows the main areas of deposition and offers broad constraints on deposition and erosional volumes which can in turn provide estimates of total bed-material influxes, the multiple assumptions and uncertainties reduce precision and accuracy. The main factors hindering robust estimates are (1) the multiple year periods between photograph sets, (2) relying upon planview changes to estimate volumetric changes and the resulting uncertainty due to poor knowledge of the thickness of eroded and deposited areas, and (3) the substantial effects of flow stage in determining areas of erosion and deposition. For the Chetco River, these issues could be overcome by a sustained program of repeated high-resolution topographic and bathymetric surveys. Much more accurate morphometric estimates of sediment accumulation and erosion could be made from such surveys, for which the LIDAR of 2008 could serve as high-quality starting point.

Bed-Material Sediment Budget for the Lower Chetco River

Consideration of all these bed-material analyses allows for an approximate sediment budget broadly consistent with many of the study observations (fig. 37). As calculated from the transport capacity equations, the average bed-material influx into the upstream end of the study reach for the 39-year period of 1970–2008 was probably in the range of 40,000–100,000 m^3/yr. Approximately 5–30 percent of this influx is probably lost to particle attrition and breakdown, and is carried to the Pacific Ocean or overbank areas by suspended load transport. The volume lost to bed-material attrition is approximately balanced by bed material supplied by tributaries to the lower Chetco River. The transport capacity calculations, channel mapping, and morphologic analyses indicate that the majority of the bed-material influx has been accumulating in depositional areas within the Mill Creek, North Fork, and Estuary reaches, with perhaps little bed-material sediment exiting the lower river. Net deposition in these reaches approximately matches or slightly exceeds the 59,000 m^3/yr extracted for aggregate during 2000–2008, but was almost certainly exceeded by the 1976–1980 rate of 140,000 m^3/yr (Marquess and Associates, 1980). The substantial downstream fining and transport capacity equations indicate that most bed material is likely retained in the lower Chetco River, with little transport, especially of gravel, to the Pacific Ocean.

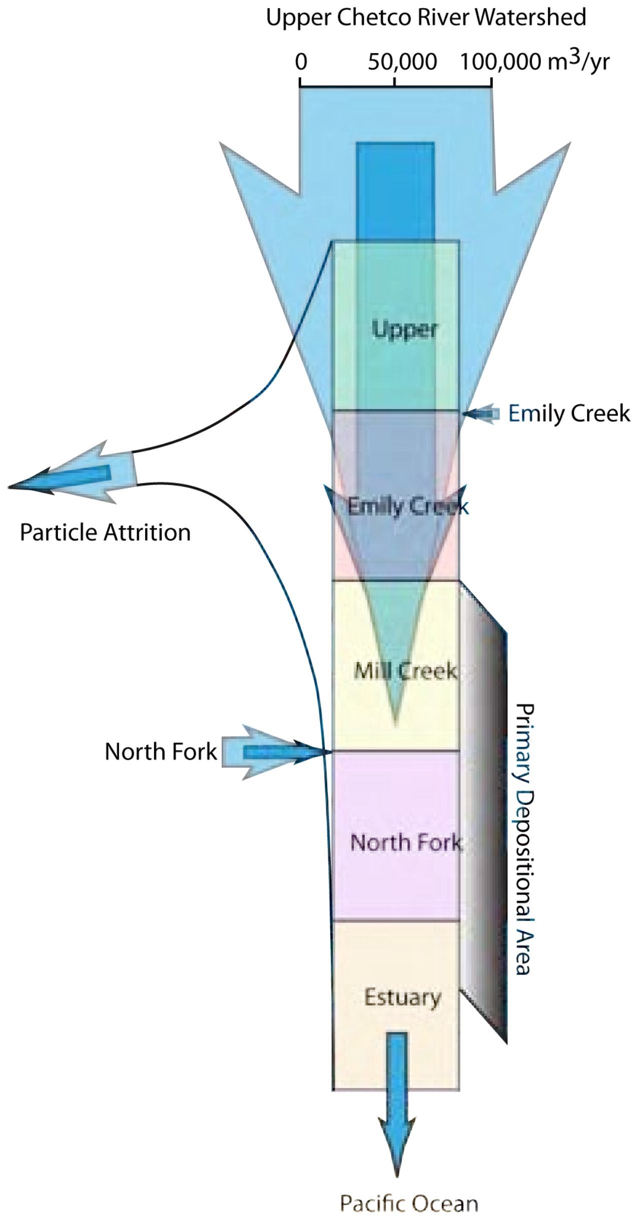


Figure 37. Schematic diagram of sediment budget for the lower Chetco River, Oregon. Arrow widths are proportional to annual flux; ranges indicate estimated uncertainty.

Comparison with Sediment Yield from Regional Drainage Basins

Although there has been little previous work on Chetco River sediment transport, geologic analyses and studies of other watersheds allow comparisons and an evaluation of the reasonableness of the results obtained here. This study focused on the key question of bed-material influx into the study reach because this is a central issue to understanding overall sediment conditions. From a wide range of considerations, including geologic uplift rates, hillslope sediment production, and actual bed-material measurement programs, estimates for bed-material production range from 26 to 610 $m^3/km^2/yr$ for several northern California and southern Oregon coastal drainage basins, with most values being between 40 and 180 $m^3/km^2/yr$ (table 8). This range translates to 28,000–126,000 m^3/yr for the 703 km^2 contributing area at the upstream end of the Chetco River study reach, encompassing the 40,000–100,000 m^3/yr predicted by the transport capacity equations and many of the period influx rates indicated by the morphologic analyses (table 7).

Table 8. Estimates of bedload production rates for northern California and southern Oregon coastal drainage basins

[**Abbreviations:** USEPA, U.S. Environmental Protection Agency; USGS, U.S. Geological Survey; m, meter; km, kilometer; yr, year. Where applicable, bedload was assumed to be 20 percent of total load. Sediment production rates for this study were scaled to the contributing area at USGS streamflow gage 14400000, 702 km^2.]

Source	Area of study	Period described	Method	Bedload production rates, m^3/km^2-yr^1
Kelsey and Bockheim, 1994	Southern Oregon Coast, including Chetco Bay	Holocene	Uplift rate, assuming equilibrium	140–180
E.G. Andrews, U.S. Geological Survey, written commun., 2008	Northern California Rivers	1950–2006	Bedload equation	26-610
USEPA, 1999	Van Duzen River, California	1955–1999	Landslide volume analysis, field mapping	80–100
Raines and Kelsey, 1991	Grouse Creek, California	1960–1989	Landslide volume analysis	130
Russell, 1994	Pistol River, Oregon	1940–1991	Landslide volume analysis	80–110
MFG Inc. and others, 2006	Smith River, Oregon	1932–2003	Calibrated bedload equation	40

Summary of Bed-Material Observations and Analyses

These analyses of bed material, transport measurements and calculations, and deposition and erosion patterns support the following observations and conclusions regarding sediment in the Chetco River:

The geologic and geomorphic environment of the lower Chetco River is of long-term bed-material accumulation in response to Holocene sea level rise. The present locus of sedimentation (and consequent channel dynamism) is in the area of the North Fork confluence. Recent and ongoing uplift in conjunction with active hillslope erosion processes supply abundant coarse detritus to the channel from much of the drainage basin.

The alluvial valley bottom, bed-sediment textures, armoring ratios, and close agreement between transport relations for bed-material transport indicate a balance between sediment supply and transport capacity at the upstream end of the study reach. Hence, Chetco River bed-material transport into the lower Chetco River is probably limited by transport capacity, rather than sediment supply.

Applying established transport equations for multiple cross sections at the upstream end of the reach gives likely mean annual bed-material transport rates into the lower Chetco River of approximately 40,000–100,000 m^3/yr for water years 1970–2008, with the reference cross section at the upstream end of the study reach giving a narrower range of 51,100–73,900 m^3/yr (fig. 31). On a per unit area, the influx values for the Chetco River are similar to those from nearby coastal drainage basins (table 8). Because of year-to-year flow variability, predicted influx of bed-material ranges from less than 3,000 m^3 in dry years to over 150,000 m^3 for wet years with large floods such as 1982 and 1997 (fig. 32).

Transport capacity, as predicted by the transport equations, diminishes substantially downstream, from values approaching the influx rates in the Upper and Emily Creek reaches to less than 10,000 m^3/yr for the North Fork and Estuary reaches (fig. 32). The decreased transport capacity of these downstream reaches is consistent with these reaches being long-term areas of sedimentation as indicated by active channel migration and bar deposition (figs. 13 and 14).

The morphologic approach to estimating bed-material influx into the study reach gives a much wider range of results, with annual reach-scale net volume changes ranging up to 200,000 m^3/yr for the 2005–8 period. For this period, this rate of bed-sediment influx is about twice that predicted by the transport relation equations. For the other two time periods when the methods can be compared, the morphologic approach gives influx rates equivalent, or less than, that predicted by the bed-material transport relations (table 7). The assumptions and uncertainties intrinsic to the morphologic approach when when based on historical aerial photographs reduce the utility of the morphologic analyses as applied for the Chetco River. But this approach could be valuable and much more accurate if based on annually collected high-resolution topographic data.

Bed material input from tributaries is approximately balanced by loss of volume by particle breakage and attrition.

The predicted downstream decrease in transport capacity, the small bed-sediment particle sizes in the downstream bars, and the rough congruence between the net volume changes determined from the morphologic method with the predicted sediment influx into the reach indicate that, in the absence of gravel extraction, most bed-material sediment entering into the lower Chetco River remains in the study reach, with most probably stored in the Mill Creek, North Fork, and Estuary Reaches.

The downstream increase in armoring and surface coarsening (fig. 22) may indicate that sediment supply in the North Fork and Estuary Reaches is less than flow capacity.

The best estimates of mean annual bed material influx from this study—40,000–100,000 m^3/yr—are of similar magnitude or slightly exceed the volume of gravel mined for the 1993–2008 period (fig. 6). For low flow years such as 2001, gravel extraction almost certainly exceeded supply. For high-flow years such as 2006, bed-material influx likely exceeded the volume mined. The voluminous gravel mining in the late 1970s (Marquess and Associates, 1980) probably exceeded replenishment rates by at least a factor of 3.

Summary

Our analysis of the lower 16 km of the gravel-bed Chetco River and its floodplain focused on understanding bed-material transport and its relation to channel and floodplain morphology. The main study components were (1) detailed mapping and surveying of the valley bottom to document spatial and temporal changes to the channel and flanking bars and floodplains and (2) quantitative investigation of the flux of bed material into and through the study reach. These study components have resulted in a mutually consistent and coherent understanding of the recent history of the active channel and how observed changes may relate to the influx and removal of bed sediment.

Primary Findings

The Chetco River is a wandering gravel-bed river flanked by abundant and large gravel bars formed of coarse bed-material sediment. The upper reaches of the study area are primarily transport zones, with bar positions fixed by valley geometry and the active bars mainly providing transient storage of bed material. The lower river has been aggrading in response to Holocene sea level rise. The Mill Creek and North Fork Reaches, between floodplain kilometer (FPkm) 5 and 10, have historically been the primary loci of this aggradation, with consequent active sedimentation and channel migration. Sediment transport capacity is limited in this reach and most net sediment influx into the study area probably accumulates here. A small amount of fine gravel is transported into the Estuary Reach. It is plausible that little gravel-sized bed sediment naturally exits the Chetco River.

The repeat surveys and map analyses indicate an overall reduction in bar area and local decreases in sinuosity, mainly between 1965 and 1995. Some loss of bar area owes to erosion and some has resulted from vegetation colonization and transition to vegetated and developed floodplain surfaces. Repeat topographic and bathymetric surveys indicate channel incision for significant portions of the study reach, with local values as high as 2 m. The specific gage analysis at the upstream end of the study reach indicates that recent incision may have followed aggradation culminating in the late 1970s. These observations are consistent with a reduction of sediment supply relative to transport capacity since at least the 1977 channel surveys. Also consistent with this is the trend of bed coarsening between FPkm 15.3 and FPkm 7.7 and the greater degree of armoring for the bars at FPkm 6 and 3 compared to a measurement at the upstream end of the reach.

Multiple and independent analyses, bolstered by direct measurements of bedload during winter 2008–09, indicate that the mean annual flux of bed material into the study reach is approximately 40,000–100,000 m^3/yr since 1970. The year-to-year flux, however, varies tremendously, with some years probably having little or no bed material entering the study reach, but for some high-flow years, such as 1982 and 1997, as much as 190,000 m^3/yr enters the reach. For comparison, the estimated annual volume of gravel extracted from the lower Chetco River for commercial aggregate has ranged from 5,000 to 90,000 m^3 and averaged about 59,000 m^3/yr between 2000 and 2008. Mined volumes, however, probably exceeded 140,000 m^3/yr for several years in the late 1970s, greatly surpassing likely replenishment rates.

The historical planform and vertical changes to the lower Chetco River, which almost certainly owe to a reduced sediment supply relative to transport capacity, have likely resulted from a combination of (1) bed-sediment removal and (2) transient effects as the river has adjusted to the probably large volume of sediment brought in by the 1964 flood. Fully disentangling these factors is not possible with existing information.

Implications Regarding Possible Future Trends and Monitoring Strategies

For a gravel-bed river such as the lower Chetco River, the physical character of the active channel is chiefly the result of bed-material transport processes. At the broad scale, the balance between bed-material transport capacity and sediment supply controls channel morphology. Details of channel conditions depend, however, on a variety of factors including the history of flow and sediment transport, the time lags involved in eroding and depositing sediment, and other local and drainage-basin-scale disturbances that might directly or indirectly affect the channel.

Despite these complexities, it is almost certain that if gravel removal exceeds bed-material influx, decreased bar areas and channel incision will ensue, similar to that of the late 1970s and 1980s. Such changes will likely be in conjunction with bed coarsening and possibly greater armoring of bar surfaces. Another probable outcome of a sediment deficit would be reduced migration rates, since bar deposition is a major cause of channel migration. Without gravel extraction, aggradation and enhanced channel migration is probable, probably first in the historical sedimentation area of the Mill Creek and North Fork Reaches. Because of the low transport capacity in these middle reaches, effects of enhanced sediment supply would probably take longer to affect the Estuary Reach. The time scales of changes depend foremost on sediment influx. A large influx associated with a flood like the one in 1964 could reverse most historical changes during the event. In contrast, the effects of sustained periods of excess transport capacity relative to sediment influx are likely to be manifest over years and decades, and possibly at diminishing rates as the channel and bars coarsen.

Because the sediment balance is a controlling factor, a key aspect of understanding possible effects of various management scenarios on the lower Chetco River is accurate knowledge of the volume of the influx of bed material. For the Chetco River, the bed-material capacity equations applied to the flow record provide seemingly reasonable estimates of bed-material influx to the lower river. This situation offers the opportunity, as long as there is continuous streamflow measurement, to provide annual (or even higher resolution) predictions of the volume of bed-material influx that could be used to guide management actions. Such analyses would be enhanced by a sustained bed-material measurement program, ideally involving at least one or two bedload transport measurements per year, to evaluate the reliability of the transport equations and ultimately develop a site specific bedload transport rating curve.

Another key for improving predictions of channel conditions and documenting effects of management actions is understanding the fate and effects of bed material sediment entering the reach. Repeat high-resolution topographic and bathymetric surveys of the entire active channel will (1) document the rates at which sediment is moving through the system, (2) allow identification of trends in vertical and planform channel behavior, and (3) provide independent assessment of the sediment influx and transport. Such surveys would ideally be supplemented by periodic bed-material sediment sampling for evaluating bed texture trends. Besides providing for direct and systematic monitoring of the active channel and enhancing understanding of key transport processes, this knowledge may be important for determining relevant management timescales by providing information on how long it may take the effects of management actions to have desired or detectable outcomes. In contrast, reach-scale interrelationships between sediment supply and channel and floodplain characteristics limit the utility of site-specific surveys for predicting and monitoring conditions in a manner responsive to typical management requirements.

From these considerations, an efficient and credible monitoring program would mainly focus on systemwide assessments of sediment influx and channel change. Sediment influx would probably be most reliably evaluated by annual analysis of the streamflow record, ideally supplemented by continued bedload transport measurements in order to improve the accuracy of the influx predictions and to confirm that the capacity-based equations remain appropriate. Continued channel-change assessments could be efficiently based on the LIDAR and estuary and channel surveys from 2008. Repeat high-resolution surveys at 1-year intervals would enable an independent check of the influx estimates as well as allow monitoring of trends in channel and floodplain conditions. These types of surveys could replace the site specific surveys with little or no loss of information relevant to trend monitoring. Even at lesser intervals, such surveys would probably provide trends and data useful for evaluating planform and vertical changes in the active channel. Monitoring of bed-sediment texture and vegetation could be less frequent (for example, 5–10 years) and would allow evaluation of how these important habitat attributes are changing with overall channel condition.

Acknowledgments

This study was guided by the State of Oregon Technical Team for instream gravel mining, chaired by Judy Linton of the Portland District of the U.S. Army Corps of Engineers, and including representatives from Oregon Department of State Lands, National Oceanic and Atmospheric Administration Fisheries, U.S. Fish and Wildlife Service, Oregon Department of Fish and Wildlife, Oregon Department of Environmental Quality, Oregon Coastal Management Program, and area gravel-mining companies. Surveying and bedload measurements were provided by the Central Point Field Office of the USGS Oregon Water Science Center under the leadership of Marc Stewart with guidance and analysis from Richard Kittelson and Roy Wellman of the Portland Field Office. John Risley of the USGS Oregon Water Science Center assisted with extending the streamflow record and Michelle Adams assisted with field measurements. Information on past gravel mining and access to measurement sites were provided by Tidewater Contractors Inc., South Coast Lumber Inc., and Freeman Rock Inc.; in particular Ted Freeman, Robert Elayer, Bill Yocum, Fred Arnold and Virgil Frazer were supportive. Ian Madin of the Oregon Department of Geology and Mineral Resources expedited transfer of LIDAR topography for our use. Bedload transport modeling was facilitated by provision of and assistance with the Bedload Assessment for Gravel-bed Streams (BAGS) software by John Pitlick, Yantao Cui, and Peter Wilcock. Robyn Darbyshire, U.S. Forest Service provided assistance with vegetation identification.

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Background Paper – Regional Gravel Initiative

GENERAL DESCRIPTION AND LOCATIONS: Portland District, Regulatory Branch is co-chairing a collaborative, interagency/industry effort to strategically evaluate, on a watershed basis, commercial gravel removal operations in Oregon rivers. The overall goal of this strategic initiative is issuance of watershed/river system regional general permits that include programmatic Endangered Species Act (ESA) Biological Opinions from the federal Services, and/or water quality certification and coastal zone concurrence determinations from the appropriate state agencies. The general permits will not only establish sideboards by which operations can occur within a given river system, but also require minimal project specific review (and associative resource commitment on the part of both state and federal regulatory agencies).

The Chetco River was chosen as the first system to be evaluated with the work product to be used by the District as a template for evaluating other river systems in Oregon. The Chetco River is located in Curry County near Brookings, Oregon in the southwest corner of the state. Portland District Regulatory Branch is pursuing the development of a regional general permit (RGP) for commercial gravel mining between the mouth and river mile 11 of the Chetco River. Evaluation of the Chetco River is occurring with a two phased approach: Phase 1 determines the vertical stability of the system and Phase 2 evaluates sediment transport. The Phase 1 determination for the Chetco River was conducted by Janine Castro, U.S. Fish and Wildlife Service in coordination with other agency personnel. Phase 2 was conducted by the U.S. Geological Survey (USGS) with money provided by the Portland District Corps of Engineers.

The Umpqua River is the second system for evaluation. Similar to the Chetco River model, Portland District is evaluating the Umpqua River studies in two Phases. The District received $614,000 from Headquarters in FY08 and has contracted with the USGS to complete both Phase 1 and Phase 2 studies. Phase 1 has been completed. Phase 2 evaluations have been initiated and are expected to be completed by December 2009 with a draft report available by April 2010.

Future systems identified for evaluation include the Tillamook, Rogue, and Coquille Rivers. A source of funding has not been identified for these systems.

NAME	AFFILIATION	Email
Gail Achterman	Institute for Natural Resources	gail.achterman@oregonstate.edu
Amy Ewing	Institute for Natural Resources	ewinga@onid.orst.edu
Kevin Moynahan	Oregon Department of State Lands	kevin.moynahan@state.or.us
Rich Angstrom	OCAPA	richangstrom@ocapa.net
Erik Peterson	US Army Corps of Engineers	Erik.S.Petersen@usace.army.mil
Megan Kleibacker	Oregon Sea Grant, OSU	megan.kleibacker@oregonstate.edu
Guillermo Giannico	Oregon Sea Grant, OSU	guillermo.giannico@oregonstate.edu
Jim O'Connor	USGS	oconnor@usgs.gov
Chris Lidstone	Lidstone and Associates	CDL@lidstone.com
Brian Cluer	NOAA	Brian.Cluer@NOAA.GOV
Dennis Halligan	Stillwater Sciences	dennis@stillwatersci.com
Desiree Tullos	Oregon State University	tullosd@engr.orst.edu
Peter Klingeman	Oregon State University	klingep@engr.orst.edu
Kim Kratz	NOAA, National Marine Fisheries Servic	Kim.Kratz@noaa.gov
Judy Linton	US Army Corps of Engineers	Judy.L.Linton@usace.army.mil
Jon Germand	Oregon Dept. of Fish and Wildlife	jon.p.germond@state.or.us
Ken Phippen	NOAA, National Marine Fisheries Servic	ken.phippen@noaa.gov
Monty Knudsen	US Fish and Wildlife Service	Monty_Knudsen@fws.gov
Janine Castro	US Fish and Wildlife Service	Janine_M_Castro@fws.gov
Chuck Wheeler	NOAA, National Marine Fisheries Servic	Chuck.Wheeler@noaa.gov
Jay Charland	Depart. Land Conservation and Develop	jay.charland@state.or.us
Lori Warner-Dickason	Oregon Department of State Lands	lori.warner-dickason@state.or.us
Bill Yocum	Freeman Rock	byocum@hughes.net
Patty Snow	Oregon Dept. of Fish and Wildlife	patty.snow@state.or.us
Bill Elayer	Tidewater Contractors, Inc.	relayer@twcontractors.com
Ted Freeman	Freeman Rock	tedf@hughes.net
Todd Confer	Oregon Dept. of Fish and Wildlife	todd.a.confer@state.or.us
Alex Liverman	Department of Environmental Quality	liverman.alex@deq.state.or.us
Joy Smith	Umpqua Sand	Joy@UmpquaSand.com
Robert Lobdell	Oregon Department of State Lands	bob.lobdell@state.or.us
Jim Thrailkill	US Fish and Wildlife Service	Jim_Thrailkill@fws.gov

Rob Burns	US Fish and Wildlife Service	Rob_Burns@fws.gov
Nina DeConcini	Department of Environmental Quality	nina.deconcini@state.or.us
Sally Puent	Department of Environmental Quality	PUENT.Sally@deq.state.or.us
Frank Burris	Oregon Sea Grant, OSU	frank.burris@oregonstate.edu
Jim Waldvogel	Oregon and California Sea Grant	cedelnorte@ucdavis.edu

From:	WARNER-DICKASON Lori
To:	LIVERMAN Alex; Chuck Wheeler; Castro, Janine; Charland, Jay; Linton, Judy L NWP; WARNER-DICKASON Lori; SNOW Patty
Cc:	kevin.moynahan@state.or.us
Subject:	My notes from the workshop
Date:	Wednesday, December 02, 2009 7:00:01 AM
Attachments:	Instream Gravel Workshop.doc

Here are my notes from the workshop. They are pretty scattered, but hopefully I captured the high points.

Judy, would you please forward these to Gail?

I am off to Mexico to return on the 15th. No need to wait for me to return to schedule the meeting. Please include Bob Lobdell.

From: Charland, Jay [mailto:jay.charland@state.or.us]
Sent: Tue 12/1/2009 7:37 PM
To: LIVERMAN Alex; Chuck Wheeler; 'Castro, Janine'; Linton, Judy L NWP; WARNER-DICKASON Lori; SNOW Patty
Subject: Tech Team Meeting

December 2

Hi all,

Good meeting today and yesterday. I am suggest we meet soon, maybe next Monday, to discuss the Proposed Action. If we can outline the PA while the meeting is fresh, maybe we could divide up and share the writing load.

Jay

PS Please forward to any Tech Team members I did not include. I don't have access to my address book.

Instream Gravel Workshop
Lori's Notes

Frank Burris: The Chetco

- Geology: have to go way up river to reach the hard material that comes into the Chetco. Very little hard material in the upland areas on the coast.

- Entire chetco is 303 d listed for temperature.

- Biscuit fire in 2002 may have increased sediment delivery for the chetco. Soils in those areas are primarily serpentine and nothing grows in it.

- South fork provides cooling water for the mainstem.

- Fish issues: Fisheries: Chinook "Limiting factor is the estuary" for Chinook. Doesn't know for COHO.

  coho are present, but probably strays. No one knows if there is a viable population. NMFS knows they are low. Historically, there was enough fish to be an independent population, according to NMFS. ODFW doesn't necessarily agree with this. ODFW thinks that off-channel habitat is limited. It is possible that this habitat was more common historically? It is possible, but there is no evidence because no sampling has been done for Coho.

  No data on spawning. Historically, some sampling but basically for Chinook. They don't see Coho very often. Late 40's some data. Early 70's sampling picked up some.

  Steelhead population is strong. Habitat is fully seeded with Steelhead. Chinook population is about half of the all-time highs. Downturn recently due to ocean conditions. Spawning between northfork and southfork. Estuary is primary rearing area.

  Are there areas that would be suitable for restoration? Frank says the area above the 101 bridge that has historical fill, could provide habitat for smolts. Low gradient shallow habitat is limited for Chinook.

  According to Frank, it hasn't been gravel extraction that has modified the estuary habitat for fish. It was the boat basin and the residential areas.

  Todd Confer: Question is whether there is enough habitat there to support an independent population. When we see COHO, we see fish from other populations. Distinct genetic legacy? Don't know. Our data started about the same time as the hatchery data.

Pacific lamprey are present, but don't know how much or where.

IS there any evidence that there was ever a sustainable independent population of coho? Todd Confer says that its debatable.

NMFS: recovery based on "potential habitat" based on modeling. Some evidence of Coho now, analysis of habitat potential indicates that Coho may have been there historically. There is no data. Recovery plan is scheduled for finishing by Feb 2010.

What do we know about historical off-channel and side channel habitat? Suspect the number is not that high. Most of systemic changes have occurred in the lower portion of the stream.

Most of the structure of the chetco was changed with the jetties and boat basin construction 1950's. The smith river populations are viable. Winchuck also has a viable population.

Coho would spawn in jack creek and north fork chetco if they use anything. According to Todd Confer, there is plenty of spawning habitat. Overwintering habitat is limiting for coho because of high, flashy flows.

Steelhead and Chinook populations are good. Should be mindful that adjustments to address coho issues, might have effect on the viable steelhead and Chinook populations. From Chris Lidstone.

USGS presentation: Questions from the hydro geo folks.

1. What was the difference between 62 and 65 in terms of plan view? It would be interesting to see what effect the 64 flood had on the plan view of the river.
2. River is focusing its deposition around KM mile 8, just north of the confluence of the north fork. This is the area of deposition.
3. Comparison of elevation of the river, relative to sea level. Less shallow habitat in the estuary than in 1939. There is more deep spots in 2008.
4. Snug harbor is no longer there. Side channel filled in. This would be a good area for restoration.
5. Channel lowering occurred since 1977. Rich asked if he evaluated the causes for the incision? And straightening? And bar amoring down stream. Jim said: Late 70's aggregate removal was occurring at very high rate and a case can be made that there is a causal relationship. But the 1964 flood caused a lot of deposition and erosion. Both factors probably played some role.
6. Sampling equipment misses some material so it underestimates transporting material.

7. The chetco river bars are relatively less armored than bars in other rivers because transport events are more frequent and transport rates are high. No chance for the material to sift out.
8. Tributaries also contribute and particle attrition (break off from larger particles to become part of the suspended flow), also influence deposition.
9. What is the appropriate timescale or spatial scale associated with management of the permit? Storm events? Annual? Depends on the physical issues one is interested in. Permitting must be concerned with the critical issues of concern (physical characteristics, fish habitat?) For example, incision could cause dewatering of side channels.
10. Related to time scale: Do we think that 10 year events are most influential in changing the physical characteristics of the river? The big bed mobilizing events really need to be considered for management of the system. Any extraction of material will disturb that bar for a long time. (Clure).
11. Questions were raised about whether or not the incision that occurred in the late 70's, and then stopped. The only thing that can be said is that the incision occurred between late 70's and 2008. There is no evidence that supports incision is not continuing. Could say that much of it occurred early during that period. Rather than focus on the cause of the incision, we should focus on a target. Do we want to shoot for that pre-late 70's elevation?
12. Is it possible that one reach can behave differently than other reaches? Shall we treat reaches differently?

Day two
Biologists
Todd Confer gave a brief summary of life histories of the 5 species that are there. The limiting factor for all species is the estuary for a small river like the Chetco. There is a lot of spawning habitat and not much rearing habitat. Chuck thinks that the upper estuary and lower river are significant for rearing.

What does Coho need and what can be done in the Chetco?
Coho like structure, woody material etc. Open areas not as effective.
IN the winter, Coho really needs to get out of the high flows. Over wintering habitat, in tribs and back channels are very important. Chetco has relatively small area of tidal influence (2 miles). Coho tend not to hang out in the tidal areas until they need to, then they make the adjustment to salt water and go out to the ocean.

Mostly, the chetco is missing the large wood, overwintering habitat and off channel low flow habitats. Old oxbows or abandoned channels with lots of cover would be beneficial to Coho. The more simplified the channel edges are, the less likely the overwintering habitat. Cobble edgewaters are also important. If there is some overwintering habitat in the mainstem between the Mill Creek reach and downstream, Coho could survive.

Chinook don't need as much structure and like the estuary.

Steelhead are everywhere. They are very mobile.

Was there habitat for coho historically? There were some back water areas in the past. This may be significant if there are only a couple of places. Those habitats are still there, are capable of being reformed either naturally or mechanically.

Snug harbor is a good restoration opportunity for coho and lamprey. Multi-species benefits. Other opportunities to install structure in Jack Creek.

What indicators are most important for assessing the health of the river and its habitat for fish?

Armored surfaces versus unembedded or unsorted materials: Armor on the end of the gravel bar is very important maintains the high velocity zones important for habitat formation processes.

Backwater areas in the mainstem.

Structure in the tributaries.

What indicators would be useful to evaluate and monitor fish habitat?
Clure: Habitat mapping needs to be done. Map fish habitat for the three life stages with aerial photos. Forensic mapping using historical air photos to assess historical habitat and potential for habitat. Then do a current habitat map to use as a baseline. Future data over a period of years, can provide an idea of whether the habitat is improving or degrading.

Chuck: Come up with an index for channel complexity using various indicators such as bed elevation, vegetation for high flow refuge, etc. Use the complexity "index" to create a base line for each reach. Then evaluate every 5 years or so and look at trends.

Look at fish densities above, below and on the site (pre-extraction) and see if there is impact over a five year period. Measure invertebrates. Look over a two or three year period. If the site is not showing much variation above or below, can assume no impact.

Todd, likes the complexity index concept. Look at channel sinuosity, and other physical parameters to evaluate channel complexity.

Focus on the lower reaches. The estuary reach is also limited because so much has been armored.

What about the estuary reach?

Some of the same complexity indicators as above would apply to the estuary. Submerged woody structure would make it more productive. Complexity also could be measured in the estuary. Logs, algae, overhanging woody veg, alcoves.

What would happen if gravel extraction stops?
With gravel operators, there is an opportunity to create more structure. Anytime the channel is manipulated it affects the river form. It's the location of the gravel bars and in what kind of area. Below the north fork and Jack Creek, happens to be the lower gradient areas of high habitat value and also the area of high gravel recruitment. This should be weighed.

Without gravel operations, these features will naturally be formed and recover.

What techniques could be used by the operators to assist with habitat restoration?
The action will be compared to the baseline, which was created through the USGS study.

Dennis: Mix of standard techniques to generate the volume the operators need, then do restorative extraction techniques.

Extraction techniques: Avoid the top 1/3 of the bar. Create low flow channels, elevational flow offset, grooming to avoid stranding fish. Create the low flow channel, secondary channels. Keep all brush on site. Salvage large wood.

Restoration actions for mitigation: Create alcoves and backwater areas on the mainstream. Root wads, brush piles.

What Indicators should be used to assess habitat?
All agreed that that we shouldn't bother with the WQ parameters like turbidity, ph, DO, and temperature. There are many other things that could affect these parameters.

Pool riffle complexes, overhanging veg, degree of bar amoring. Instead of degree of incision, look at riffle crest elevation.

Develop an index of complexity to evaluate every 5 years.

Benthic community may also contribute to our knowledge of habitat.

Geology experts:

Discussion about "incision". Do we want to arrest this process or encourage this process of incision and channel widening? The types of things we see with incised channels, we are not seeing. What we are seeing in the chetco is areas of local incisions that extend across a couple of meanders. What we look for in a degrading system is a trend away from this state of going up and down and back and forth. Is the Chetco showing signs of degradation? t is evident that there has been incision in certain reaches. Whether it is the type of incision that adversely affects habitat is the question. There is not evidence of systematic channel incision. Localized incision. Is two meters of incision relevant? Don't know. Could be within the range of variability.

The group has not reached consensus that downcutting is "bad". A net change in bed elevation could be part of the natural variation.

One way to see if there is a degrading situation is to look at the partical size distribution. The coarser material is left behind.

What indicators would be most relevant for assessing "health of the river"?

Klingeman: Would want to evaluate the plan form of the river. Instead of "health of the river" he thinks in terms of the "condition of the river". Would look at things such as shape of the bars, channel depth adjacent to the bars to get a sense of how the flow had maintained depth. Look at where the system curves, whether it is able to pool. Looking for a high variety of water depth, and sinuosity and the ability to develop a secondary current or spiraling action. This builds the bar in the downstream direction. He would want to see that we don't have too much homogeneity. Overhanging bank vegetation, large wood structure.

Chris would want to look at physical characteristics that affect habitat. These were mentioned earlier. Focus on geo-morphological features that affect habitat or are indicative of habitat.

Jim would look for specific needs of the river in terms of habitat. System wide things would include channel bed elevation, variability of that elevation, bar texture. These could be easily measured on a reach scale. Would allow us to evaluate trends.

Desiree: Need to be more specific of the indicators. Frequency and duration of floodplain connectivity. "degree of armoring" is not measurable. Somebody needs to develop a "concept map" between geo-morphological indicators and biological significance. Then develop indicators to assess those.

Clure: Plan form is really important. Windshield tour every year. Trib connectivity is also important. Trib mouths are a long way from the river. Previous to that, the tribs were right next to the mainstem. This is significant. systems perspective. We want resiliency. We compromise the resiliency when we remove armor layers, not letting it evolve to a more sinuous form, and other disturbances.

Question 3:

Is a recovery period necessary? For specific reaches?

Not sure there was ever really a balance. It is an area of long- term deposition. North fork reach and mill creek reach could use more meandering. Take more gravel out of that reach than is coming in, would make meandering difficult. IS there some physical manipulation that could be done to accelerate that?

Two choices, let the system evolve on its own and return to meandering, or encourage it. It needs a rest period if these measures to encourage meandering are not going to be incorporated.

There are some localized issues, like riparian growth that could be addressed.

Pete: There are some things that are going on that are part of a long-term cycle of events. We just cannot deal with the issue of "recovery" in isolation.

Recovery implies that there is some desired condition that we are trying to achieve, which is impossible to define in this case.

Question 4:

Use the model and annual flow data to estimate recruitment into the system. It makes sense.

Need to have some conservative estimate of how much is recruited. Sediment budgets can be a good planning tool. It shouldn't be the only tool that is used to estimate how much material should be removed. Has to be used in the context of the overall system and balanced with site specific analysis and site restoration activities.

Chris: From a practical standpoint, the operators need to have some certainty and be able to plan for a base level of extraction every year.

Jim: Some sort of sediment budget needs to be a point of departure. IF you take more gravel out than comes in, bad things happen. The best way to know what's coming in is the model compared with flow data. Need also to understand where the gravel is ending up. For the mill creek and north fork reaches, want to confirm that gravel is ending up there.

Pete: It would be useful to have a better definition of the bedload curve. It would make folks feel more comfortable in using the mass balance approach to estimate recruitment. Collect more bed material data to build the model.

Desiree: LIDAR? Turnaround time may not allow for annual permit decisions related to where or how much removal can take place every year. LIDAR would be an effective tool for monitoring long-term changes in the river, but impractical for annual permit decisions.

Question 5:

LIDAR would be most useful on periodic basis.

Topographic mapping is most useful. Digital terrain mapping is very effective. High resolution topographic mapping highly encouraged. Lidar is only one method.

For annual extraction? Flow annually. Other targeted indicators to address location specific issues.

Longer term? System health attributes (most of the physical characteristics) could be evaluated periodically (5 years) to determine if our process is working. Nice thing about the gravel rich chetco, there is gravel moving through and if we start to see adverse trends, the river will recover.

Pete: Take selected transects and make them reference transects. The location of the reference transects should be in a stable location. At a specific discharge, go down to these transects and measure the cross section. Track in these fixed areas it would give you a good idea of the longer-term incision.

In California, these indicators are used as triggers for various actions, including more information and ceasing operations.

Other things to monitor: Ripple crest elevation, residual pool depth and pool volume, bar relief (difference between top of the bar and elevation of the adjacent pool), edge complexity measure are other indicators.

Question 8: IF gravel extraction ceased, what would happen?

Long-term history is that of aggradation in the lower 12 miles of the river. The locust of the aggradation appears to be in the North fork and mill creek reaches.

WE would expect that to continue with or without extraction. This can have beneficial habitat effects. Flooding and navigability can be adversely affected.

Question 6: Management techniques

Focus on the N fork and mill creek reaches. Taking out more of the lower bar might enhance meandering.

Tech Team Questions recap:

Our proposal:

Annually: We propose to determine whether removal can occur based on a volume threshold for any given year. (The system threshold) Volume threshold based on the flows for that year plugged into the model.

If the threshold was met, and gravel removal is appropriate, we would then need to consider how much gravel (what percentage) could be removed and from where.

Use the habitat priority areas to decide where material could be removed.

Discussion: Clure is a fan of getting on the ground data by direct measurement. Better to look at the site to see how much was recruited. Using cross sections of Dtmodels to fine tune what came in where.

Do Lidar only every 3-5 years. Have permit conditions that allow for removal annually and make local adjustment of removal based on what is recruited at that spot. Monitor system wide on longer term (3-5 years), and determine removal amounts by surveys to determine what was being recruited. Pre and post removal surveys for just the bar itself.

Instead, could remove material down to a specific final bar configuration, down to a baseline elevation.

From:	Charland, Jay
To:	LIVERMAN Alex; LOBDELL Robert; Chris Lidstone; Chuck Wheeler; Castro, Janine; Charland, Jay; Linton, Judy L NWP; WARNER-DICKASON Lori; SNOW Patty; rich@ocapa.net; Yvonne Vallette
Cc:	Petersen, Erik S NWP; Ellis, Karla G NWP; MOYNAHAN Kevin
Subject:	Photos
Date:	Thursday, December 03, 2009 10:48:31 AM
Attachments:	Rocks above road.JPG Rocks and River.JPG Rocks and Road.JPG Upslope.JPG

Hi all,

Great meeting this week. I think it went very well, and gave a clear indication of what is known and what is not known about gravel generation, movement, and importance to the ecology of the river.

I was in the mountains on Wednesday on another project, and happened across this landslide way up on the East Fork of the Coquille. This area does not feed any commercial operations I know of, but does pass through the small crossroads of Gravelford. Anyway, I had gravel on my mind, and I thought this look at early gravel generation was interesting.

Jay Charland | Coastal State-Federal Relations Coordinator
Oregon Coastal Management Program
Oregon Dept. of Land Conservation and Development
635 Capitol Street NE, Suite 150 | Salem, OR 97301-2540
Office: (503) 373-0050 ext. 253 | Cell: (971) 239-9460 | Fax: (503) 378-6033
jay.charland@state.or.us | www.oregon.gov/LCD

From:	Linton, Judy L NWP
To:	Linton, Judy L NWP; "Charland, Jay"; "Alex Liverman"; "Chuck Wheeler"; "Castro, Janine"; "WARNER-DICKASON Lori"; "SNOW Patty"; "LOBDELL Robert"; "Yvonne Vallette"; "rich@ocapa.net"; "Chris Lidstone"
Cc:	Petersen, Erik S NWP; "MOYNAHAN Kevin"
Subject:	RE: Tech Team Meeting
Date:	Friday, December 04, 2009 3:53:50 PM
Attachments:	Gravel RGP draft 17Nov09 .doc Gravel RGP draft 17Nov09 .doc

Here are the particulars for the Tuesday (Dec 8) Tech Team meeting:

Location: DEQ Regional Offices in Portland, 2020 SW 4th Ave (at Lincoln) near PSU. We'll meet in the conference room on the first floor (door under stairwell past elevators).

Teleconference Number: (888)285-4585; PARTICIPANT CODE: 914107

Objectives:
* Review gravel workshop outcomes
* Begin discussion regarding RGP/GP proposed action
    - excavation methods
    - adaptive management process
    - mitigation/restoration opportunities

Attachments:
* Preliminary Draft RGP
    - Information taken from November 2008 public notice and other tech team discussions (e.g. preliminary monitoring requirements/data needs). There are no doubt changes needed based on the workshop but it is a starting point.
* San Francisco District Letter of Permission Procedure for Gravel Mining in Humboldt County, CA
    - Provided primarily as a reference
    - Appendix C describes monitoring/survey requirements that may be beneficial

Let me know if questions or comments - Judy

-----Original Message-----
From: Linton, Judy L NWP
Sent: Thursday, December 03, 2009 9:25 AM
To: 'Charland, Jay'; 'Alex Liverman'; 'Chuck Wheeler'; 'Castro, Janine'; 'WARNER-DICKASON Lori'; 'SNOW Patty'; 'LOBDELL Robert'; 'Yvonne Vallette'; 'rich@ocapa.net'; 'Chris Lidstone'
Cc: Petersen, Erik S NWP; 'MOYNAHAN Kevin'; Ellis, Karla G NWP
Subject: RE: Tech Team Meeting

Thanks, Jay for getting the ball rolling on scheduling a tech team meeting. Let's plan on meeting Tuesday Dec 8 from 1-3p.

I'll see about getting a room at the Corps offices and will send out details in a later email. I'll also send out my draft-to-date version of the rgp for us to use as a starting point and will also send out the Letter of Permission process SF District uses for gravel mining. It may contain useful information for our purposes.

Judy
-----Original Message-----
From: Charland, Jay [mailto:jay.charland@state.or.us]
Sent: Tuesday, December 01, 2009 7:38 PM
To: Alex Liverman; Chuck Wheeler; 'Castro, Janine'; Linton, Judy L NWP; WARNER-DICKASON Lori; SNOW Patty
Subject: Tech Team Meeting

December 2

Hi all,

Good meeting today and yesterday. I am suggest we meet soon, maybe next Monday, to discuss the Proposed Action. If we can outline the PA while the meeting is fresh, maybe we could divide up and share the writing load.

Jay

PS Please forward to any Tech Team members I did not include. I don't have access to my address book.

DEPARTMENT OF THE ARMY PERMIT

REGIONAL GENERAL PERMIT
FOR
COMMERCIAL GRAVEL MINING IN THE CHETCO RIVER
CURRY COUNTY, OREGON

PERMIT NO.: NWP-2008-00071

EFFECTIVE DATE: ________________, 2010

EXPIRATION DATE: ________________, 2015

ISSUING OFFICE: U.S. Army Corps of Engineers, Portland District

This general permit authorizes commercial gravel mining activities within the Chetco River, Curry County, Oregon subject to the terms and conditions contained herein. This general permit is issued upon the recommendation of the Chief of Engineers as provided by 33 CFR 325.2(e)(2), pursuant to Section 404 of the Clean Water Act (P.L. 95-217) and Section 10 of the Rivers and Harbors Act of 1899.

1. PROJECT PURPOSE: To obtain aggregate for industrial and commercial purposes.

2. PROJECT LOCATION: This RGP is geographically limited to the portion of the Chetco River from the mouth to river mile 11 in Curry County, Oregon. Specific project locations within this 11 mile stretch are identified below and shown on Figures 1 through 4.

Comment [g1]: See November 2008 public notice for drawings.

1) Tidewater Bar site: Located on the south bank of the Chetco River at mile 2.0. This site is located within the estuary and is subject to diurnal tidal fluctuations during which the bar may be exposed or totally inundated. This site is located in Section 33 of Township 40 South, Range 13 West. (See Figure 1).

2) Freeman Bar site: Includes several sites which are located on the north and south banks of the Chetco River between river miles 4.5 and 5.5. The sites are located in Sections 34 and 35 of Township 40 South, Range 13 West. (See Freeman Bar Location Map, Figure 2).

3) South Coast Lumber site: This site includes two adjacent river bars (the lower bar on the north bank and the upper bar on the south bank) at about river mile 7.0 of the Chetco River. The site is located in Sections 24 and 25 of Township 40 South, Range 13 West. (See Figure 3).

4) 2nd Bridge Bar (aka Fitzhugh Bar) site: This site is located just upriver from the bridge that crosses over the Chetco River at about river mile 10.2. This site is located in Section 12 of Township 40 South, Range 13 West. (See Figure 4).

PROJECT DESCRIPTION:

A. Extraction Methods. Under the RGP, gravel mining would be authorized to occur over a five-year period at the identified project locations using one or more of the methods described below. It is possible the use of certain methods may be confined to specific locations in the Chetco River (for example, at an upriver location but not within the estuary). Individual mining methods have been developed to minimize, eliminate or remediate impacts to the channel or adjacent properties.

Comment [g2]: These methods are taken from the November 2008 public notice and may need to be modified.

Unless otherwise stated, these methods may be used at any of the proposed project locations.

- Bar Removal. Sand and gravel removal would be located on large gravel bar adjacent to the river channel. The width, depth, and cross section shape would be based on adjacent river channels. (A Typical Diagram of the Bar Removal Technique is shown on Figure 5).
    a. Head of bar. Protect the upper 1/3 of the bar from any excavation activities.
    b. Lateral Buffer. The area between the low flow channel and the active mining area would be one foot elevational difference. Buffer widths (horizontal distance) will be set based on site specific conditions.
    c. Excavated length. The lower 2/3 of the gravel bar would be shaped with a slope towards the river plus a slope towards the downstream direction of the river.
    d. Excavated head slope. This portion of the excavated area would be no steeper than 10:1 (horizontal to vertical).

Comment [g3]: USFWS recommends lateral buffer be no less than 20% of the active channel width, or be set on site specific conditions.

- Horseshoe. Horseshoe construction would be located on large gravel bar adjacent to the river channel. The width, depth, and cross section shape would be based on adjacent river channels. (A Typical Diagram of the Horeshoe Construction method is shown in Figure 6).
    a. Head of bar. Protect the upper 1/3 of the bar from any excavation activities.
    b. Lateral buffer. The set-back area between the low flow channel and the active mining area will be set based on site specific conditions.
    c. Excavated backwater length. Maximum excavated backwater length is 2/3 of the total length of the bar feature.
    d. Excavated backwater area. The area of the excavated backwater would be constrained by the established buffers except on the lower end where it would be designed to breach with over-topping during the fall and winter freshets. The depth of the backwater bottom would be

above the low water level except for a narrow deep channel. This narrow deep channel would have a width of less than 10% of the width of the bar. The maximum depth of the narrow deep channel would be the same as the deepest part of the active river channel. The length of the narrow deep channel would have a maximum excavated length of 1/2 of the bar feature.

e. Excavated backwater head slope. This portion of the excavated backwater area would be no steeper than 10:1 (horizontal to vertical).
f. Excavated side slopes. This portion of the excavated backwater area would be no steeper than 4:1 (horizontal to vertical).

- Alcove. Alcove construction would be located on the downstream end of the North Fork Chetco Gravel Bar (see the Freeman Bar Location Map, Figure 1). The purpose would be to increase vertical structure or diversity to this reach of the river while relieving the hydrologic pressures of the confluence from the North Fork of the Checto with the mainstem of the River. The width, depth, and cross section shape will be based on the adjacent river channel. The maximum depth will be the same as the deepest part of the active river channel. The excavated side slopes will be no steeper than 4:1 (horizontal to vertical); the shape would curve along the alignment of the old channel. The downstream buffer of the alcove will have a portion that is designed to breach when over-topping occurs during the fall and winter freshets.

- Backwater or trench construction. The width, depth, and cross section shape would be based on adjacent river channels. (A Typical Diagram of the Backwater/Trench Construction Method is shown in Figure 7).
  a. Lateral buffers. The set-back area between the low flow channel and the active mining area would be no less than 20 feet from the active channel. Other lateral buffers may be set based on site specific conditions.
  b. Excavated backwater length. Maximum excavated backwater length would be within 20' of the head of bar.
  c. Excavated backwater area. The area of the excavated backwater would be constrained by the established buffers except on the lower end where it would be designed to breach with over-topping during the fall and winter freshets.
  d. Excavated backwater head slope. This portion of the excavated backwater area would be no steeper than 4:1 (horizontal to vertical).
  e. Excavated side slopes. This portion of the excavated backwater area would be no steeper than 4:1 (horizontal to vertical).

Comment [g4]: USFWS recommends upper third of bar be protected from mining.

- Small ponds. Two small ponds of approximately three acres each could be constructed near the high-water mark on the south side of upper Freeman Bar (see Freeman Bar Location Map, Figure 1). Because of the elevation/location of these small ponds the location would be on lands where DOGAMI and

DSL both have jurisdiction. Volume removed would be around 20,000 CY per pond.

The intent is to use this method only during times of extreme drought periods, when the annual return of sand and gravel is not adequate to supply the needs of the local communities. The ponds would be constructed well away from the wetted channel and as such would not interfere with low flow habitat. The maximum depth would be the not exceed the thalweg of the active river channel. The shape would curve along the alignment of the old channel. Excavated side slopes would be no steeper than 4H:1V and any vegetation cleared during construction of the ponds would be placed in the ponds.

- Pit Extraction behind Protective Berm. This method has been used at Tidewater's estuary site for over 35 years. The general procedure is to construct a protective berm during low tide events on the river side of the extraction site. The berm is at a height sufficient to keep water from flowing into the extraction area during high tide events. Once the berm is in place, the extraction process can take place safely, even during tidal fluctuations. The area behind the protective berm is dug to a depth of no greater than the thalweg of the river channel. After the extraction is complete and the turbidity in the pool settles, the berm is removed and the pit is opened to the river at both ends.

  This described extraction plan is similar to the backwater or trench construction method. The excavation is confined to the lower 2/3 of the gravel bar length where naturally occurring alcoves generally form. These alcoves provide a deep, slow water refuge for juvenile salmonids during moderate to high velocity flows.

  See Figures 8 through 11 for a Typical Diagram of the Pit Extraction Method.

B. Equipment and Access. The type of equipment used to excavate the sand and gravel would include paddlewheel scrapers, excavators, front-end loaders, and dump trucks. Approved temporary crossings of the Chetco River with a flatcar bridge would be used to access the opposite side of the river at some locations. The only in-water river crossing would be for installation of the temporary bridge. Temporary crossings of dry channels would require a stabilized low water ford or the installation of culverts that would allow for fish passage if the water level rose during the removal season.

ADAPTIVE MANAGEMENT

An interagency technical team is discussing the concept of including adaptive management into the RGP/GP. Adaptive management would allow the above list of project design features to be modified if site specific conditions warrant and if there is common agreement between the regulatory and resource agencies and the permittee. The determination of whether modifications to the project design are appropriate would be based on the evaluation of a pre-harvest plan and any changes that have occurred to the physical and biological characteristics of the river in the vicinity of the extraction site. Adaptive management helps maintain flexibility by recognizing uncertainties exist and gives the agencies latitude to improve the project design features by moving towards the desired outcome of minimal effects to the aquatic and terrestrial ecosystem.

MONITORING REQUIREMENTS

1. Annually conduct two LIDAR flights (one in June/July and one in Sept/Oct) along the entire lower Chetco system (~RM 0-12). If no material is removed from the system, conduct one flight in June/July.

2a. Conduct longitudinal profiles of the channel thalweg for the lower Chetco (~RM 0-12) after two years with peak flows of ~10,000 cfs (several years could pass before this occurs) or after any year with a peak flow of ~45,000 cfs.
2b. Conduct point bar analysis at locations from USGS study during the same years as longitudinal profiles are taken.

3. Annual stream flow analysis utilizing gage data and other applicable information to more accurately estimate annual sediment transport rates.

4. Annually conduct bedload sampling at the USGS streamflow gaging station (one site visit per year).

4. Monitoring.

- A pre-harvest (spring) and post-harvest (fall) survey will be conducted by the operator.
- Vehicle staging areas will be designated for cleaning, maintenance, refueling, and monitoring for petroleum leaks and repairs. This staging area will be no closer than 150’ from any water. All equipment will be cleaned before starting the removal season. Daily inspection will be preformed on all vehicles for fluid leaks. Any leaks detected will be repaired before leaving the staging area to perform removal activities. Documented inspections will be logged in a record that will become part of the post-harvest report.
- Established photo points with pictures being taken once a week during the removal season. The photo points with pictures will become part of the post-harvest report.
- Turbidity monitoring will be conducted and recorded every four hours either visually or with a turbidimeter during the removal operations. (*Specific turbidity monitoring requirements will be developed as part of the RGP process and are expected to be contained in any water quality certification issued by the Oregon Department of Environmental Quality*).

Comment [g5]: This is from previous permits – don’t know how much of this we want to keep.

- A post-harvest report will be completed by the end of December following the removal season.

CONDITIONS

1. **In-water Work Window:** All in-water work shall be conducted during the listed in-water work window, as applicable, unless otherwise approved by the Corps of Engineers. (Refer to Oregon Department of Fish and Wildlife (ODFW) "Oregon Guidelines for Timing of In-Water Work to Protect Fish and Wildlife Resources" http://www.dfw.state.or.us/lands/inwater/inwater_guide.pdf).

Cultural Resources and Human Burials-Inadvertent Discovery Plan: Permittees shall immediately cease all ground disturbing activities and notify the Portland District Regulatory Branch if at any time during the course of the work authorized, human burials, cultural items, or historic properties, as identified by the National Historic Preservation Act and Native American Graves and Repatriation Act, are discovered and/or may be affected. The Permittee shall follow the procedures outlined below:

- Immediately cease all ground disturbing activities.
- Notify the Portland District Regulatory Branch. Notification shall be made by fax (503-808-4375) as soon as possible following discovery but in no case later than 24 hours. The fax shall clearly specify the purpose is to report a cultural resource discovery.
- Follow up the fax notification by contacting the Corps representative (by email and telephone) identified in the permit letter.
- Project Located in Oregon: Notify the Oregon State Historic Preservation Office (503-986-0674).

Failure to stop work immediately and until such time as the Corps has coordinated with all appropriate agencies and complied with the provisions of 33 CFR 325, Appendix C, the National Historic Preservation Act, Native American Graves and Repatriation Act and other pertinent regulations, could result in violation of state and federal laws. Violators are subject to civil and criminal penalties.

2. **Erosion Control:** During construction, permittee shall ensure that all practicable erosion and sediment control measures are installed and maintained in good working order to prevent unauthorized discharge of materials carried by precipitation, snow melt, wind or any other conveyance mechanism into any waterways and wetlands. The permittee is referred to Oregon Department of Environmental Quality's (DEQ) *Oregon Sediment and Erosion Control Manual*, April 2005, for proper implementation of practicable sediment and erosion control measures.

4. **Hazardous, Toxic, and Waste Materials.** Petroleum products, chemicals, fresh cement, construction debris, or other deleterious waste materials shall not be allowed to enter waterways or wetlands.

5. **Heavy Equipment.**

a. Permittee shall ensure that all heavy equipment is operated from the bank and not placed in the stream except under the following conditions:

i. The streambed consists of bedrock, or where no compaction will occur in the streambed and only minimal compaction will occur in the floodplain; or
ii. There is no surface flow in the channel; or
iii. Equipment cannot safely reach the channel work site due to steep and/or rugged terrain; or
iv. It is necessary to cross the stream to avoid springs, wetlands, or other sensitive areas; or
v. It is necessary to avoid or minimize disturbance of riparian vegetation that is serving a unique or valuable function.

b. Equipment used for in-stream work must be cleaned prior to entering the two-year flood plain and otherwise prepared to protect against the release of any petroleum products, chemicals or deleterious materials. Wash and rinse water must not be discharged into waterways, unless adequately treated.

c. Heavy equipment working in wetlands must be placed on removable mats or pads. Following the removal of the mats or pads, the area must be restored to pre-project conditions.

6. **Fish Passage.** The activities authorized by this general permit must not restrict fish passage.

7. **Fills Within 100-Year Floodplains.** The activity must comply with applicable FEMA-approved state or local floodplain management requirements.

8. **Flooding.** The project must not cause the water to rise or be redirected in such a manner that it results in flooding, or deleterious or harmful impacts to any structures or substantial property outside of the project reach;

9. **Tribal Rights**. No activity or its operation may impair reserved tribal rights, including, but not limited to, reserved water rights and treaty fishing and hunting rights.

10. **Endangered Species Act (ESA) Compliance**.

11. **Navigation.**

a. No activity may cause more than a minimal adverse affect on navigation.

b. The permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structure of work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the permittee will be required, upon due notice from the Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

12. **Inspection of the Project Site.** The permittee shall allow representatives of the Corps to inspect the authorized activity to confirm compliance with the general permit terms and conditions. A request for access to the site will normally be made sufficiently in advance to allow a property owner or representative to be on site with the Corps representative conducting the inspection.

13. **Water Quality.** All activities authorized under this general permit must comply with the Water Quality Certification issued by the Oregon Department of Environmental Quality.

14. **Coastal Zone Management.**

SPECIAL CONDITIONS (from Nov 2008 public notice)- this would probably be integrated into one condition section

Special conditions will be added to the RGP and GP based on a number of factors associated with the evaluation of the proposed action including the results of studies being conducted on the Chetco River, coordination with state and federal resource agencies, and comments received in response to the public review process. Actual conditions have not yet been developed; however, special conditions may include requirements such as those listed below.

1. Removal operations will be limited to the daylight hours.

2. No removal of vegetation will occur outside the designated work area on gravel bars. The only removal of vegetation will be for operational reasons.

3. During removal operations, gravel bars will be constantly graded and sloped to avoid fish entrapment.

5. Pollution and Erosion Control Plans. Such plans may require following Best Management Practices to minimize pollution from being introduced into the river. Such BMPs may include:
   - Sequence/Phasing of work – work will be scheduled so as to minimize potential turbidity in the water.

- Equipment control – all excavation and relocation of material by machinery will be completed so as to minimize turbidity.
- Machinery will not drive into the active flowing channel except for one crossing to place a temporary bridge and one crossing for the removal of the temporary bridge.
- Excavated material will be placed so that it is isolated from the water edge and not placed where it could re-enter the river or natural drainage to the river.

Use of containment measures such as silt curtains, geoblocks, geotextile fabric, and silt fence will be implemented where needed and properly maintained to minimize instream sediment suspension and resulting turbidity.

LIMITS OF THIS AUTHORIZATION

a. This general permit does not obviate the need to obtain other Federal, state or local authorizations required by law.

b. This general permit does not grant any property rights or exclusive privileges.

c. This general permit does not authorize any injury to the property or rights of others.

d. This general permit does not authorize interference with any existing or proposed Federal project.

LIMITS OF FEDERAL LIABILITY

In issuing this permit, the Federal Government does not assume any liability for the following:

a. Damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes.

b. Damages to the permitted project or uses thereof as a result of current or future activities undertaken by or on behalf of the United States in the public interest.

c. Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity authorized by this permit.

d. Design or construction deficiencies associated with the permitted work.

e. Damage claims associated with any future modification, suspension, or revocation of this permit.

REEVALUATION OF PERMIT DECISION

The District Engineer may reevaluate this general permit at any time, and, if appropriate, suspend, modify, or revoke this permit as provided in 33 CFR 325.7. The District Engineer may also suspend, modify, or revoke authorization under this general permit for any specific geographic area, class of activities, or class of waters within the state of Oregon.

This general permit will be reviewed annually to determine whether the projects authorized by this general permit result in no more than minimal effects, both individually and cumulatively, and to ensure that the terms and conditions of this permit are being observed. The District Engineer will invite the participation of other interested federal and state agencies in this review. If this review concludes that changes in permit terms or conditions are warranted, modification of the permit will be proposed as provided in 33 CFR 325.7, including public notice and opportunity for comment.

Activities authorized under this general permit that are under construction or under contract for construction in reliance upon this authorization will remain authorized provided the activity is completed within 12 months of the date of this general permit's expiration, modification or revocation, unless the District Engineer has exercised his discretionary authority to modify, suspend, or revoke the authorization of a specific project in accordance with Corps regulations.

EXPIRATION OF THIS AUTHORITY

This general permit will expire five years from the date on which it becomes effective, unless it is extended prior to that date.

BY AUTHORITY OF THE SECRETARY OF THE ARMY:

______________________________ ____________________

Steven R. Miles, P.E. (Date)
Colonel, Corps of Engineers
District Commander

From:	Bill Yocum
To:	rich@ocapa.net; virgilf@socomi.com; relayer@twcontractors.com; tedf@hughes.net; cedelnorte@ucdavis.edu; Todd.A.Confer@state.or.us
Cc:	kevin.moynahan@state.or.us; robert.lobdell@dsl.state.or.us; Lori.Warner-Dickason@state.or.us; Petersen, Erik S NWP; Linton, Judy L NWP; jabar40@dishmail.net
Subject:	Monday and Tuesday"s Meetings
Date:	Friday, December 18, 2009 1:06:50 PM
Attachments:	Proposed Agenda.docx permit yardage by operator.docx Data Gaps 12_09.docx

In Preparation for our Monday (12/21) and Tuesday (12/22) adventures, I have developed the attached proposed agenda with a couple of supporting documents. This is only a starting point to make our time more efficient and should be refined on Monday and Tuesday. Currently, Ted has reserved the side room in Wild River Pizza for Monday evening and the side room in Smugglers Cove for Tuesday Morning. If you have any questions then please let us know. Thanks and we'll see you on Monday at Social Security Bar.

Bill

541-482-2789

Proposed Agenda
for
Monday, 12/21/09 and Tuesday 12/22/09

Monday, 12/21/09

1:30 pm Meet at Social Security Bar to review on-the-ground possible restoration projects such as: Jacks Creek, North Fk. Chetco, Joe Hall Creek, NE of Hwy 101 Bridge.

5:00 pm Meet at Wild River Pizza (Harbor, OR) to discuss:

- Restoration verses Mitigation Projects and any potential projects.
- Proposed annual aggregate allocation for Tidewater, Freeman and South Coast (see attached document titled Permit Yardage by Operator).
- Possible recommendations to narrow existing data gaps with possibility of increasing aggregate availability (see attached document titled Data Gaps 12/09).
- Refine agenda for 12/22/09 meeting with agency personnel.

Tuesday, 12/22/09

8:00 am Meet at Smugglers Cove Restaurant with agency personnel.

- Rich to start discussions on potential restoration projects.
- Rich to start discussions on proposed annual aggregate allocation for operators.

9:30 am On-the-ground review of proposed restoration projects.

11:30 am Rich to lead discussion for wrap-up.

Chetco Aggregate Removed
from
2001 to 2005

Operator	Location	River Mile	2001	2002	2003	2004	2005	Total	Percent
Tidewater	Tidewater Bar	RM 2	40,000[1]	41,500[2]	35,241[2]	31,687[2]	0[2]	148,428	34%
FreemanRM	Freeman Bar	RM 4	48,595[1]	48,595[1]	51,420[1]	36,616[1]	54,000[1]	239,226	54%
So. Coast Lbr.	Tamba Bar	RM 7	10,000[1]	0[1]	8,591[1]	8,923[1]	10,238[1]	27,752	6%
Tidewater	Fithugh Bar	RM 11	0[1]	0[1]	12,012[2]	13,083[1]	0[2]	25,095	6%
							Totals =	440,501	100%

[1] Yardage from DSL Records

[2] Yardage from Tidewater

[3] Yardage from So. Coast Lbr.

2009 Identified Data Gaps affecting Chetco River Ecological Analysis

Information presented at the November 30th to December 1, 2009 Charleston Regional Gravel Initiative Workshop exposed three data gaps. Below are the data gaps and a Freeman Rock recommendation for shortening these gaps.

Chetco River SONC coho Salmon: Is there or can there be a viable, sustainable SONC Coho population in the Chetco system? NMFS believes that there is a sustainable population. ODFW does not agree with NMFS analysis and conclusion on this subject because of the lack of habitat. There is no historical evidence that significant Coho population ever existed in the Chetco system.

Freeman Rock Recommendation: ODFW and NMFS need to work together to design a process for inventorying the limiting factor of overwinter habitat. Opportunities for adaptive management practices to enhance habitat from gravel removal should be encouraged and monitored.

Chetco River Estuary aggregate: What is the source of the material dredged each year? The biological arm of the agencies believes that the dredged estuary material is a marine source. Local observations support the theory that the estuary sediment source is a combination of river and marine, particularly with respect to large particle size. If a significant portion of the aggregate is coming from the river then the analysis that estuary deepening caused by upstream aggregate removal sites might be flawed.

Freeman Rock Recommendation: When the Yaquina (Corps suction dredge) is performing the annual Chetco Estuary dredging a sediment removal map could be developed that would identify the location of the gravel and sand deposits. The deposits can be identified by visual observations of the material being placed in the hopper of the Yaquina. Freeman Rock would be willing to draft up a proposal and assist with the inventory, mapping and analysis of estuary sediments.

Chetco Aggregate Attrition: How much aggregate volume loss is due to bed-material attrition? The USGS study stated that approximately 5-30 percent of bed-material is loss to particle attrition and breakdown, and is carried to the Pacific Ocean or overbank areas by suspended load transport. The USGS study further states that this 5-30% loss is approximately balanced by bed material supplied by tributaries to the lower Chetco River. *It's not clear to me why this is important, except perhaps, for understanding turbidity in the stream flow. Arguably, the more suspended sediment in the river, the less important the little bit that might get stirred up through gravel removal would be. That said, I am painfully ignorant on the subject.*

Freeman Rock Recommendation: To narrow this gap or estimate of loss to particle attrition a series of transects could be established just below second bridge, above and below the major tributaries and at head of tide. These transects would measure particle size and the ratio of competent and incompetent aggregate. Freeman Rock would be willing to draft up a proposal and assist with the inventory, mapping and analysis.

12/09 whyocum

If the Technical and/or Executive Team is interested in narrowing the data gaps through partnering with Freeman Rock, then please contact Ted Freeman at tedf@hughes.net or 541-469-2444.

From:	Linton, Judy L NWP
To:	"Alex Liverman"; "Bill Yocum"; "Bob Lobdell"; "Chris Lidstone"; "Chuck Wheeler"; "Janine Castro"; "Jay Charland"; "Jim O"Connor"; "Jodi Fritts"; Linton, Judy L NWP; "Lori Warner-Dickason"; "Patty Snow"; "Rich Angstrom"; "Robert Elayer"; "Rose Wallick"; "Todd Confer"; "Yvonne Vallette"
Subject:	FW: Regional Gravel Initiative - Exec Team response to several issues raised at the last Tech Team meeting.
Date:	Monday, December 21, 2009 10:10:09 AM
Attachments:	12 21 direction to Tech Team final.doc
Importance:	High

Sorry if you have already seen this but I wanted to make sure all Tech Team members were aware.
Judy

-----Original Message-----
From: MOYNAHAN Kevin [mailto:kevin.moynahan@state.or.us]
Sent: Monday, December 21, 2009 9:23 AM
To: bob lobdell; bill yocum; Petersen, Erik S NWP; George Edwards; BAILEY Bob (Bob.Bailey@state.or.us); CHARLAND Jay (Jay.Charland@state.or.us); joe_zisa@fws.gov; Jon Germond; joy@umpquasand.com; Linton, Judy L NWP; kevin moynahan; Kim Kratz; Evans, Lawrence C NWP; lori warner-dickason; marcella lafayette; monty_knudsen@fws.gov; Nancy Johnson; Nina Deconcini; SNOW Patty; David Pratt; relayer@twcontractors.com; rich@ocapa.net; PUENT Sally; szerlog.michael@epa.gov; tedf@hughes.net; vallette.yvonne@epamail.epa.gov
Subject: Regional Gravel Initiative - Exec Team response to several issues raised at the last Tech Team meeting.
Importance: High

DSL and the Corps have drafted the following Exec Team direction in response to issues raised at the Tech Team meeting. Comments received from Exec Team members on the draft were incorporated into the text as appropriate.

If you have any questions, please speak with Erik or myself.

Thank you.

Kevin Moynahan

From: MOYNAHAN Kevin
To: bob lobdell; bill yocum; Petersen, Erik S NWP; George Edwards; BAILEY Bob (Bob.Bailey@state.or.us); CHARLAND Jay (Jay.Charland@state.or.us); joe_zisa@fws.gov; Jon Germond; joy@umpquasand.com; Linton, Judy L NWP; kevin moynahan; Kim Kratz; Evans, Lawrence C NWP; lori warner-dickason; marcella lafayette; monty_knudsen@fws.gov; Nancy Johnson; Nina Deconcini; SNOW Patty; David Pratt; relayer@twcontractors.com; rich@ocapa.net; PUENT Sally; szerlog.michael@epa.gov; tedf@hughes.net; vallette.yvonne@epamail.epa.gov
Subject: Regional Gravel Initiative - Exec Team response to several issues raised at the last Tech Team meeting.
Date: Monday, December 21, 2009 9:27:19 AM
Attachments: 12 21 direction to Tech Team final.doc
Importance: High

DSL and the Corps have drafted the following Exec Team direction in response to issues raised at the Tech Team meeting. Comments received from Exec Team members on the draft were incorporated into the text as appropriate.

If you have any questions, please speak with Erik or myself.

Thank you.

Kevin Moynahan

Regional Gravel Initiative - Exec Team Direction
December 21, 2009

The overall goal of the Regional Gravel Initiative, as set forth in the Charter, remains for the Corps and DSL to consider developing RGPs and GPs for commercial gravel operations in various watersheds throughout Oregon. It is the role of the Exec Team to ensure progress continues and to provide support and direction to the Tech Team. As such, the Exec Team is providing the following comments and direction to the Tech Team related to post-workshop permit development process.

1) An issue was raised at the December 8, 2009 Tech Team meeting concerning how the decision-making process related to the annual assessments of whether gravel can be excavated from the Chetco will work. Will it be a full-blown CHERT type process or something else?

It will not be possible to have a full CHERT process in place in time to make decisions for the 2010 in-water work period. Setting up a full CHERT process is a goal for down the road - but it will take time and $$ to accomplish. We do not have funding or an organizational structure in place to accomplish the creation of a CHERT type process at this time. DSL and the Corps strongly believe the existing Exec and Tech Team process provides a viable alternative that will allow for informed and defensible decision-making related to the GP/RGP.

Here is what DSL and the Corps consider a reasonable alternative to get us where we need to in the framework of the GP/RGP process. We are not attempting to list out here all the details of this process - just the general framework. We are also not addressing the actual conditioning of the permit for items like bar protection, sloping etc - the Tech Team should continue to work thru those issues in the development of proposed permit conditions. The direction herein is focused more on the framework for the decision-making process.

First, the Tech Team should propose to the Exec Team foundational triggers for annual decision-making for gravel extraction on the Chetco. This would include:

- Agreed upon flow/recruitment triggers - 10 cfs, 45 cfs etc, based on a flow/duration/recruitment/transport algorithm utilizing USGS gauge data (and the findings in the USGS report that outline the relationship between flow at certain levels for a certain duration and sediment recruitment). If the flow is over a certain trigger point during a given winter, that would allow for the possibility of gravel to be extracted from the system during the in-water work season later in the summer. Agreed upon flow/recruitment triggers may be tied to c/y being available for extraction. In concept, the higher the flow and longer the duration, the more c/ys that may be considered for removal that season. The flow/recruitment trigger data should be considered by late March/early April - the end of the typical high flow season on the Chetco. The flow/recruitment trigger for the Chetco should be assessed on an annual basis as new data on the flow/duration/recruitment/transport relationship is developed.
- If extraction is available based on flow/recruitment triggers, set a percentage of that recruitment for removal. Any percentage less than 100% should ensure that more material is left in the system than was recruited that year. This percentage should be reviewed annually as part of the adaptive management under the respective permits. Suggested percentage for discussion purposes for the initial year of the permits - 50%

Once the agreed upon foundational triggers for annual decision-making are set, the agencies need to commit to timely review and decision-making related to the annual data from the triggers and how they will be applied. This review process and associated decisions need to be completed in time to allow the operators to gear up for the in-water work period for extraction. If there is a low water year and the initial flow/recruitment trigger (10 cfs over a certain duration?) is not met - the decision should be easy and made early on - no extraction that season. Additional criteria to be addressed include:

- If extraction is available based on flow/recruitment triggers, there should be decision criteria and permit conditioning regarding which reaches are available for extraction based on on-site observed temporal and spatial dynamics in the system that season. This will involve adaptive management and should be accommodated in the respective permits.

- If extraction is available based on flow/recruitment triggers, the permitting agencies and industry need to commit to meeting (in April/May - or at the earliest appropriate time) to assess the data including conducting an on the ground assessment of the relevant sections of the system. The permits need to be flexible enough to allow for adaptive management based on these assessments.
- Recommendations from the Tech Team on these and other assessments shall be provided to the Exec Team at appropriate points. Final decisions on annual adaptations and decision points under the permits rests with the permitting agencies. Final decisions in years where flow/recruitment triggers and associated decisions allow extraction should be made in time to allow the operators to plan for and gear up their excavation operations for the in-water work period.

2) An issue was raised at the December 8, 2009Tech Team meeting concerning the operators undertaking mitigation/restoration activities on the Chetco associated with excavation activities. The operators have indicated a commitment to undertaking reasonable restoration activities as mitigation for impacts of their operations. OCAPA has indicated the operators already have some ideas on potential projects - Jack Creek, opportunities on the lower Tidewater Bar, possibly Snug Harbor, and others. There was good discussion at the workshop related to the many impacts on the Chetco system over the years including from historical geological events, flooding, recent development, fires in the Kalmiopsis, channelization and management of the estuary and mouth of the river. The gravel operations have not caused all the negative impacts to the system and the operators are not responsible for, or capable of, fixing all of them. At the same time, impacts from gravel extraction may not be limited to the spatial or temporal extent of the individual operations. It is therefore not unreasonable to plan for and expect some mitigation in parts of the Chetco system removed from the

extraction sites. The Exec Team appreciates the commitment of industry to discussing and implementing reasonable mitigation/restoration options as part of the permitting process.

- Appropriate mitigation/restoration and BMPs should be developed and integrated into the permits. These should include consideration of projects to improve over-watering habitat for Coho. There is an opportunity next week for agencies and operators to meet on the Chetco to explore these options further and the Exec Team encourages participation in this opportunity.

If there are any questions, please direct them to Erik Peterson and myself.

Thank you for your continuing efforts on this important project.

From:	Petersen, Erik S NWP
To:	Ellis, Karla G NWP; Linton, Judy L NWP
Subject:	FW: Regional Gravel Initiative - Exec Team response to several issues raised at the last Tech Team meeting.
Date:	Tuesday, December 22, 2009 1:01:46 PM

-----Original Message-----
From: Petersen, Erik S NWP
Sent: Tuesday, December 22, 2009 12:58 PM
To: 'kim.kratz@noaa.gov'
Cc: MOYNAHAN Kevin
Subject: RE: Regional Gravel Initiative - Exec Team response to several issues raised at the last Tech Team meeting.

Kim, greetings.

I understand that Kevin had a commitment from you to respond to our direction to the Tech Team by last Wednesday. I'm not sure what happened, as neither he or I have heard back from you. Given recent efforts and expressed urgency, it is unfortunate that NMFS apparently doesn't consider the Regional Gravel Initiative enough of a priority to find the time to review and comment on the e-mail.

DSL and the Corps were asked by Tech Team members to make a quick turnaround in addressing these issues. We followed protocol in sending the draft guidance we developed out for Exec Team comment and then incorporated comments received into the final direction. There really aren't any surprises in the final direction.

DSL and the Corps, along with most of the other other partners in the Regional Gravel Initiative, have committed to moving this process along in a reasonable and collaborative manner. One of the goals is to make decisions on permits in time for the next in-water work period in 2010. This is particularly important considering we missed commitments to make decisions in time for the 2009 in-water work season.

If NMFS has substantive issues with the direction the Regional Gravel Initiative is going, it is imperative that DSL and the Corps are advised of those concerns at the earliest opportunity. Particularly after all the time, effort and expense of conducting the recent workshops which were intended to inform the process and expedite decisions.

Thanks, Erik

From: PUENT Sally [mailto:sally.puent@state.or.us]
Sent: Monday, December 21, 2009 9:29 AM
To: MOYNAHAN Kevin
Cc: Petersen, Erik S NWP
Subject: RE: Regional Gravel Initiative - Exec Team response to several issues raised at the last Tech Team meeting.

Kevin: I have not yet had a chance—because of other priorities-- to review your recent email and will not be able to get to that or this until the first of the year. So, I want to be clear that DEQ doesn't necessary agree with this direction. We will be weighing in January, but I will not have a chance before that. Sally

Sally Puent

DEQ--NW Region

Water Quality Manager

503-229-5379

From: MOYNAHAN Kevin
Sent: Monday, December 21, 2009 9:23 AM
To: LOBDELL Bob; bill yocum; Petersen, Erik S NWP; George Edwards; BAILEY Bob (Bob.Bailey@state.or.us); CHARLAND Jay (Jay.Charland@state.or.us); joe_zisa@fws.gov; GERMOND Jon P; joy@umpquasand.com; judy.l.linton@usace.army.mil; MOYNAHAN Kevin; Kim Kratz; lawrence.c.evans@nwp01.usace.army.mil; WARNER-DICKASON Lori; marcella lafayette; monty_knudsen@fws.gov; Nancy Johnson; Nina Deconcini; SNOW Patty; David Pratt; relayer@twcontractors.com; rich@ocapa.net; PUENT Sally; szerlog.michael@epa.gov; tedf@hughes.net; vallette.yvonne@epamail.epa.gov
Subject: Regional Gravel Initiative - Exec Team response to several issues raised at the last Tech Team meeting.
Importance: High

DSL and the Corps have drafted the following Exec Team direction in response to issues raised at the Tech Team meeting. Comments received from Exec Team members on the draft were incorporated into the text as appropriate.

If you have any questions, please speak with Erik or myself.

Thank you.

Kevin Moynahan

From:	Chuck Wheeler
To:	Jim O"Connor
Cc:	Linton, Judy L NWP; WARNER-DICKASON Lori; LIVERMAN Alex; Charland, Jay
Subject:	Re: Tech Team workgroup mtg-follow up
Date:	Monday, December 28, 2009 10:41:49 AM

Jim, Thanks for the reply. That's what I get for sending a message 15 minutes after I was supposed to be gone on Christmas Eve.

Everyone, In the end, what really matters is the final recommendation, of which I did make the conversion from cubic meters to cubic feet incorrectly. And I really don't know why I converted to cubic feet instead of cubic yards. So this is how it should read (and I clarified a couple other things too):

Final recommendation:

After looking at information pertaining to water discharge, flow elevation, bar heights, and annual gravel influx, and relating it to the processes that result in building gravel bars, the most appropriate trigger for extraction to protect bar building processes is an annual gravel influx of at least 26,000 cubic yards as calculated from the Parker equation using the past winter's discharge.

Jim O'Connor wrote:
> Chuck and others;
> Hope you all had or are having a good break.
> Just a couple points of clarification...
>
> From Chuck's first set of points...
> 1. True
> 2. Not sure I mean't this exactly. Bars build from both lateral and
> vertical accretion. Lateral accretion is probably more important in
> the North Fork confluence area where the channel moves around more.
> 3. True
> 4. Calculations were made at 7 of the 60 or so flow modeling cross
> sections. Gravel mobilization was predicted in all cases at more or
> less the stage where the bars became inundated.
> 5 and 6. Instantaneous peak discharge does correlate with calculated
> annual gravel influx, but the correlation is weaker than for total
> winter (October through April) flow volume. Moreover, from the
> existing model it is straightforward to calculate total gravel influx,
> so I'm not sure why one would want to rely on the correlations.
>
> Regarding Chuck's second set of key data observations...
> 1. Chuck's observation is slightly misstated. Annual gravel influx is
> always less than 20,000 cubic meters (according to Parker equation) if
> peak discharge is less than 25,000 cubic feet per second.
> 2. True, and flows of 25,000 cfs have been exceeded 34 out of 40 years.
> 3. To restate with correct numbers..Annual gravel influx (as predicted
> by the Parker equation) has exceeded 20,000 cubic meters 32 out of 40
> years (80%) (as calculated by the Parker equation).
>
> Regarding Chuck's thoughts...
> 1. Seems logical
> 2. I think Chuck means 20,000 cubic meters
> 3. I would agree
> 4. Bar building probably is relatively frequent on the Chetco

>
> Hope this helps...Jim
>
> Chuck Wheeler wrote:
>> Everyone, I have spent a couple hours talking to Jim since our
>> meeting. As usual, I oversimplified the situation. After me asking
>> him multiple convoluted questions that likely made little sense, he
>> gave me some input that I believe will answer our question. i have
>> cc:ed Jim in case I misinterpreted anything.
>>
>> To re-cap the question, I was in charge of finding a trigger for
>> extraction that had real-world justification for bar building
>> processes. Here are some of the key points I gathered from Jim:
>>
>> 1. We are better grounded technically by using a total gravel influx
>> volume than a discharge metric.
>> 2. Bars build from lateral accretion more than vertical accretion.
>> 3. The bars are totally inundated at a flow of 20,000 cfs.
>> 4. Calculations were made at each of the crosssections to see at
>> what flows where bed mobilization occurs, they were all around where
>> the bars were overtopped (20,000 cfs).
>> 5. Instantaneous (peak) discharge is highly variable, but still a
>> good correlation for the total gravel influx.
>> 6. Discharge metrics with a longer time duration (total winter flow
>> volume) are better correlated with gravel influx than an
>> instantaneous (peak) discharge.
>>
>> Key data observations derived from the real data:
>>
>> 1. Annual gravel influx is 60,000 cf or less when a peak flow of
>> 20,000 cfs is not exceeded.
>> 2. Flows of 20,000 cfs have been exceeded 36 out of 40 years (90%).
>> 3. Annual gravel influx of 60,000 cf or greater has occurred 34 out
>> of 40 years (85%).
>>
>> Chuck's thoughts:
>> 1. We have strong evidence to justify the relationship of bar
>> building processes with a peak flow trigger of 20,000 cfs.
>> 2. We have strong evidence to justify the relationship of bar
>> building processes with a annual gravel flux trigger of 60,000 cf.
>> 3. A stronger tie to reality can be made using annual grave flux.
>> 4. The events (measured either as peak flow or annual gravel flux)
>> that lead to bar building processes occur more frequent than I
>> expected (85-90% of the time).
>>
>> Final recommendation:
>>
>> After looking at information pertaining to water discharge, flow
>> elevation, bar heights, and annual gravel influx, and relating it to
>> the processes that result in building gravel bars, the most
>> appropriate trigger for extraction to protect bar building processes
>> is an annual gravel influx of 60,000 cf.
>>
>>
>>
>

From:	WARNER-DICKASON Lori
To:	LIVERMAN Alex; Chuck Wheeler; CHARLAND Jay; Linton, Judy L NWP
Cc:	LOBDELL Robert; MOYNAHAN Kevin; WARNER-DICKASON Lori
Subject:	Chetco, draft options for adaptive management-revised
Date:	Thursday, December 31, 2009 4:34:53 PM
Attachments:	Options for adaptive management.doc Option chart for the RGPGP.doc

I took the notes from the last tech team meeting and created two documents: a narrative that describes the three options and a chart that shows an example. I also tried to incorporate the information that Chuck obtained from Jim. I may have gotten the numbers confused, so please check this, Chuck.

Please review and provide edits. Note that I am sending this only to the folks that attended the tech meeting last week. I wanted you folks to review it to make sure I captured the conversation before we sent to a wider audience.

I also sent to Kevin Moynahan and Bob Lobdell to keep them in the loop.

Happy New Year all!

Lori Warner-Dickason, Western Region Manager
Wetlands and Waterways Conservation Division
Oregon Department of State Lands
(503) 986-5271
(503)378-4844 (fax)
lori.warner-dickason@state.or.us

Notes from the Tech Team Mtg
December 23, 2009

The Tech Team discussed three options for adaptive management of the gravel extraction operations on the Chetco.

Concepts

A Recruitment volume ("Rv") trigger will be established based on flow velocity and duration that will likely result in bar forming activity. After looking at information pertaining to water discharge, flow elevation, bar heights, and annual gravel influx, and relating it to the processes that result in building gravel bars, the most appropriate trigger for extraction to protect bar building processes is an annual gravel influx of at least 26,000 cubic yards (20,000 cubic meters) as calculated from the Parker equation using the past winter's discharge. This appears to happen in 32 out of 40 years.

1. If flow and duration data for a specified time period indicate that recruited volume is greater than the Rv, gravel extraction can be conducted.
2. The percentage of the Rv that will be allowed for extraction for the entire system will be established at 25%. That percentage will be further adjusted based on deposition (+), suspended load (-), tributary inputs (+) and volume for the river (-).

Option 1: Annual Review Option

1. Flow data is evaluated on an annual basis to determine if the Rv trigger is met.
2. If met, then 25% of the volume that is recruited may be extracted from the river. If not, no extraction can occur for that year.
3. The volume is allocated equally among the three operations. [1]
4. Surveys are conducted to confirm that the allocated volume was recruited for each location.

Advantages:

A. Operators could remove material more frequently

Disadvantages:

A. Less certainty for operators
B. More intensive management

Option 2: Multi-year Review Option

1. Extraction occurs on a repeating cycle: no extraction for three years, extraction on the 4th year.

[1] The tech team recommends distributing the total volume of extraction equally at all locations in an effort to minimize impacts at any one location.

2. Flow data is collected and recorded annually.
3. If the Rv is met on any given year, then 25% of that volume is “banked” for extraction.
4. The accumulated volume is allocated equally among the three operations for extraction in the 4th year.
5. Surveys are conducted to confirm that the allocated volume was recruited for each location.

Option 3: Flow Event Option

1. The trigger for whether extraction can occur is established as the 5-year flow event.
2. Extraction can occur if the 5-year event occurs that year.
3. The volume available for extraction will be established in one of three ways:
    a. The volume is based on what can be removed and still retain the bar form (no upper limit), or
    b. The volume of extractable material is based on the amount of material that has accumulated since the last extraction (cumulatively), applying the 25% limit, or
    c. The volume of extractable material is based on some other rationale (ask Janine)
4. Surveys are conducted to confirm that the allocated volume was recruited for each location.

Advantages:

- Operators could obtain a large volume of material from a high flow event.
- Extraction can occur when the river is in an already disturbed state and the impacts would be less. This approach is most protective of the resource.

Disadvantages:

- Less certainty for operators.

Example Chart Illustrating the Extraction Volumes for the Three Adaptive Management Options for the RGP/GP

		2009	2010	2011	2012	
	Rv (cubic meters) (measured)	75,000	80,000	102,000	18,000	
Options		Amount of Extractable Material				
Annual Review		18,750	20,000	25,500	0	
Multi-year Review		Rest	Rest	Rest	64,250	
Flow Event		0	0	TBD based on surveys and final bar configuration	0	

For the purpose of this example, the established Rv is 20,000 cubic meters and the 5 year event is 100,000 cy.