Reproductive Timing of Freshwater Mussels and Potential Impacts of Pulsed Flows on Reproductive Success

Spring Rivers Ecological Sciences, LLC
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Funding provided by:
Mussel Reproductive Cycle

1. Spawning

2. Release of parasitic larvae “glochidia”

3. Juveniles drop off of hosts

Embryos in Gill (Gravid Anodonta)

Embryos in Gill (Gravid Gonidea angulata)
Project Goal

Determine when native California mussels may be most vulnerable to pulsed flows by investigating seasonal reproductive timing in the Pit River drainage (Shasta County)

- Spawning
- Glochidial release
- Juvenile drop-off/settlement
Pit River Mussels

winged floater
Anodonta nutalliana
(a.k.a. wahlamatensis)

California floater
Anodonta californiensis
Forest Service Sensitive

Anodonta oregonensis rare in Pit River and not studied
Pit River Mussels

western ridged-shell
Gonidea angulata

western pearlshell
Margaritifera falcata
Study Area

Pacific Gas and Electric Company's (PG&E's) Pit River Hydroelectric Dams

- Water diverted through tunnel
- Dam
- Powerhouse
Study Reaches

2. Pit River downstream of Pit 1 Powerhouse
   - 700 cfs minimum flow
   - Daily flow fluctuations from hydroelectric peaking

1. Pit 4 Bypass
   - 150 cfs minimum release (during this study)
   - Stable summer flow (seasonal runoff fluctuations)

3. Pit 1 Bypass
   - 150 cfs summer base flow
   - Daily flow fluctuations (spring & early summer)
   - 3 summer pulsed flows
4. Hat Creek
   • Stable, run-of-the-river flow

5. Fall River
   • Stable, unregulated flow
Study Dates

April through November 2004

- 3 Pit River reaches

February 2005 through early May 2006

- 3 Pit River reaches, Hat Creek, & Fall River
Methods

Mussels collected and examined for gravidity

- 10 mussels per genus in each study reach
- Every 2 weeks (4 weeks in winter)
Mussels sampled, marked, and returned to river

- 0.01 ml fluid collected from the marsupia
- Eggs/embryos examined under 4X or 10X magnification

Gonidea angulata adult

Gonidea angulata from marsupium
Stream drift samples collected and examined for glochidia

- 53-μ-mesh plankton nets set for 30-60 minutes
- Drift samples examined under dissecting microscope using cross-polarized light

G. angulata glochidia  

G. angulata on copepod
Fish collected and examined for glochidia

- Backpack electroshocker in Pit River
- Seines, cast nets, and hook and line in Hat Creek and Fall River

Anodonta on fish fin

G. angulata on fish gill
Fish held in aquaria to collect juvenile mussels that drop off of fish

- Fish separated into aquarium tanks by species
- Tank bottoms vacuumed every 3 days

Gonidea angulata juveniles
Results
Anodonta—found in all study reaches

- Reproductive timing similar in all reaches & years

**Gravid adults**

**Glochidia on fish (rarely found in stream drift)**

**Juveniles dropped off of hosts held in aquaria**

Duration of Aquaria Study

**Host Fish:** native hardhead, Sacramento pikeminnow, Pit sculpin, tule perch, and non-native green sunfish
Gravid adults

Glochidia in stream drift and on fish

Juveniles dropped off of hosts held in aquaria

Duration of Aquaria Study

Host Fish: native hardhead, Pit sculpin, and tule perch
Margaritifera falcata—rare in Pit 1 Bypass, not found in Fall River

- Reproductive timing differed between reaches & years

Gravid adults (few were found in any survey location)

- 2004 Pit 4 Bypass
- 2005 Pit 4 Bypass
- 2005 Pit River d/s Pit 1 PH
- 2005 Hat Creek

No glochidia in stream drift or on fish

No juveniles in freshwater aquaria

No Margaritifera under 50 mm in length were found in any location
Summary All Species

Critical Reproductive Events

Peak period
G. angulata

Pit River d/s Pit 1 PH
Pit 4 Bypass

2005 River Discharge

6000 cfs
4000 cfs
2000 cfs

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
Summary All Species

Critical Reproductive Events

- Peak period
  - G. angulata

2005 River Discharge

- 6000 cfs
- 4000 cfs
- 2000 cfs
- 1000 cfs
- 200 cfs

Pit 1 Bypass
- 3 pulsed flows
- ≤ 1250 cfs
Conclusions

In the Pit River, pulsed flows or spills would have the least impact on mussel recruitment if scheduled after August.

Pulsed flows or spills would have the greatest impact on *Gonidea angulata* recruitment during June and July.

The pulsed flows in the Pit 1 Bypass could have adversely affected recruitment in *Gonidea angulata*.

- Additional studies are needed to quantify impacts of pulsed flows on mussel recruitment and adult survival.
Pulsed flows may impact recruitment in *Gonidea* and *Margaritifera* more than in *Anodonta*

*Margaritifera* may be especially vulnerable to pulsed flows

- reproductive timing appears to be more sensitive to river conditions
Recruitment was not observed for *Margaritifera falcata* in the Pit River drainage

- This potential problem should be more thoroughly investigated
Mussel reproductive timing should be investigated in all rivers that experience pulsed flows. These data should be included in the planning of all pulsed flow events to minimize adverse effects on freshwater mussel reproduction.