# Effects of Daily Fluctuations in Streamflow on Stream Metabolic Activity


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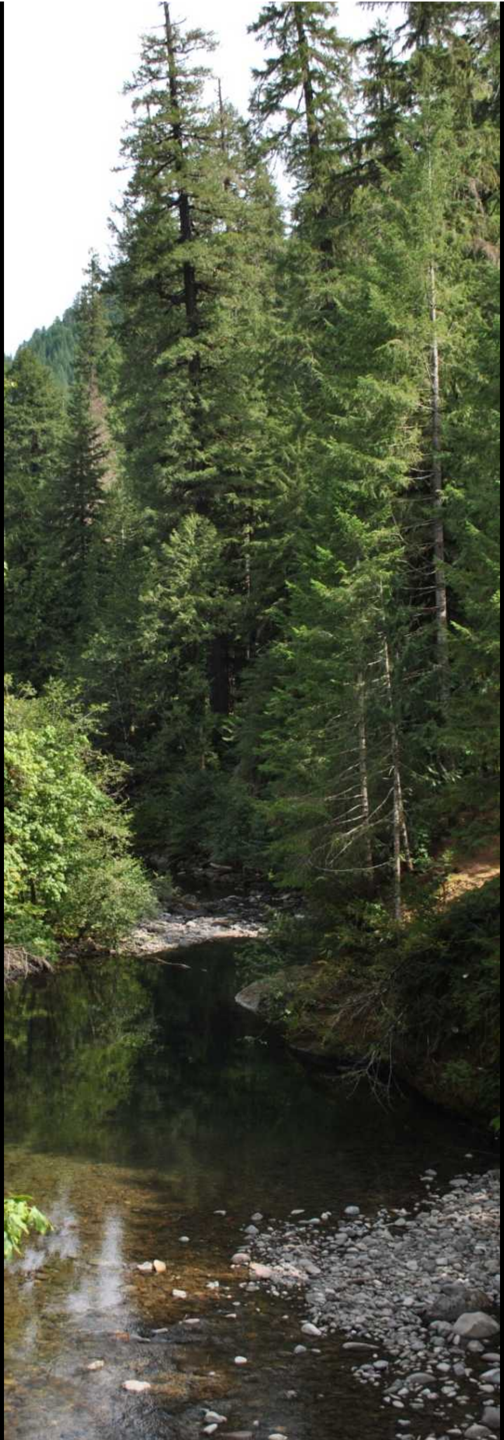
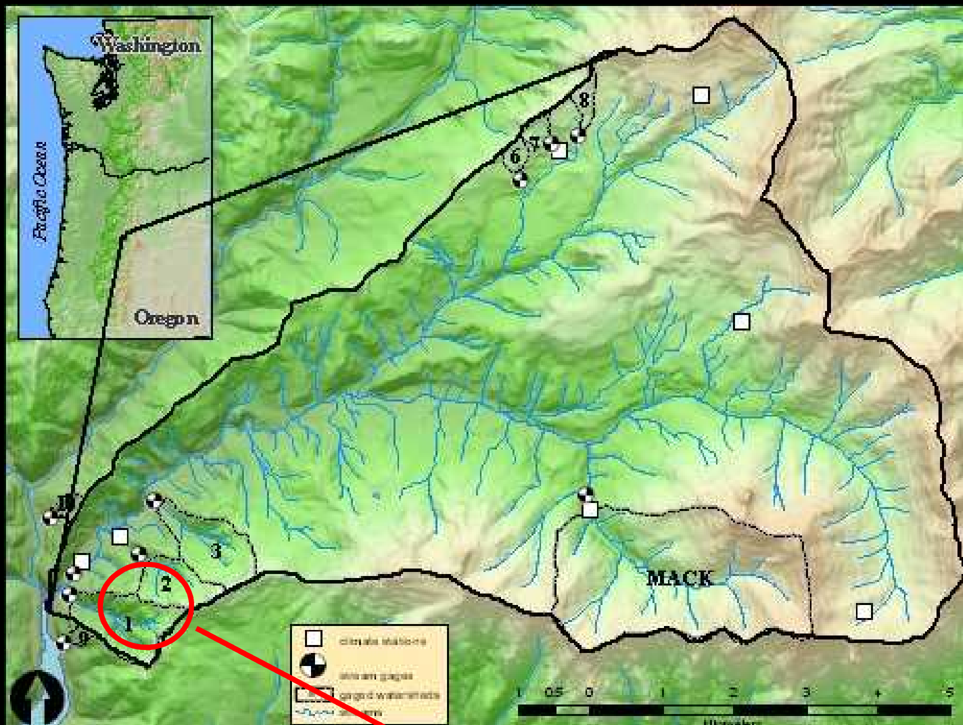


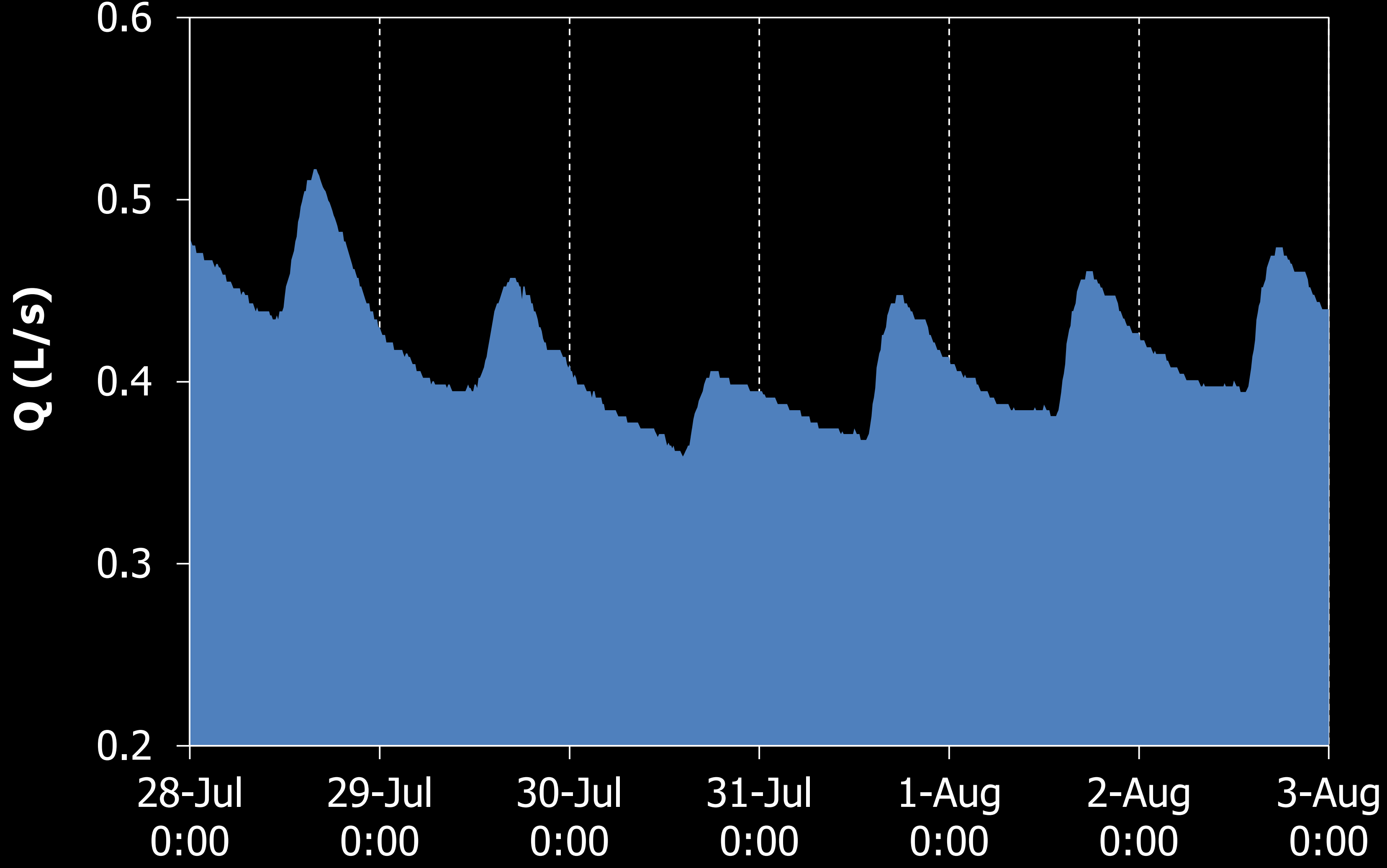
# Study site & methods

## H.J. Andrews Experimental Forest




WS1

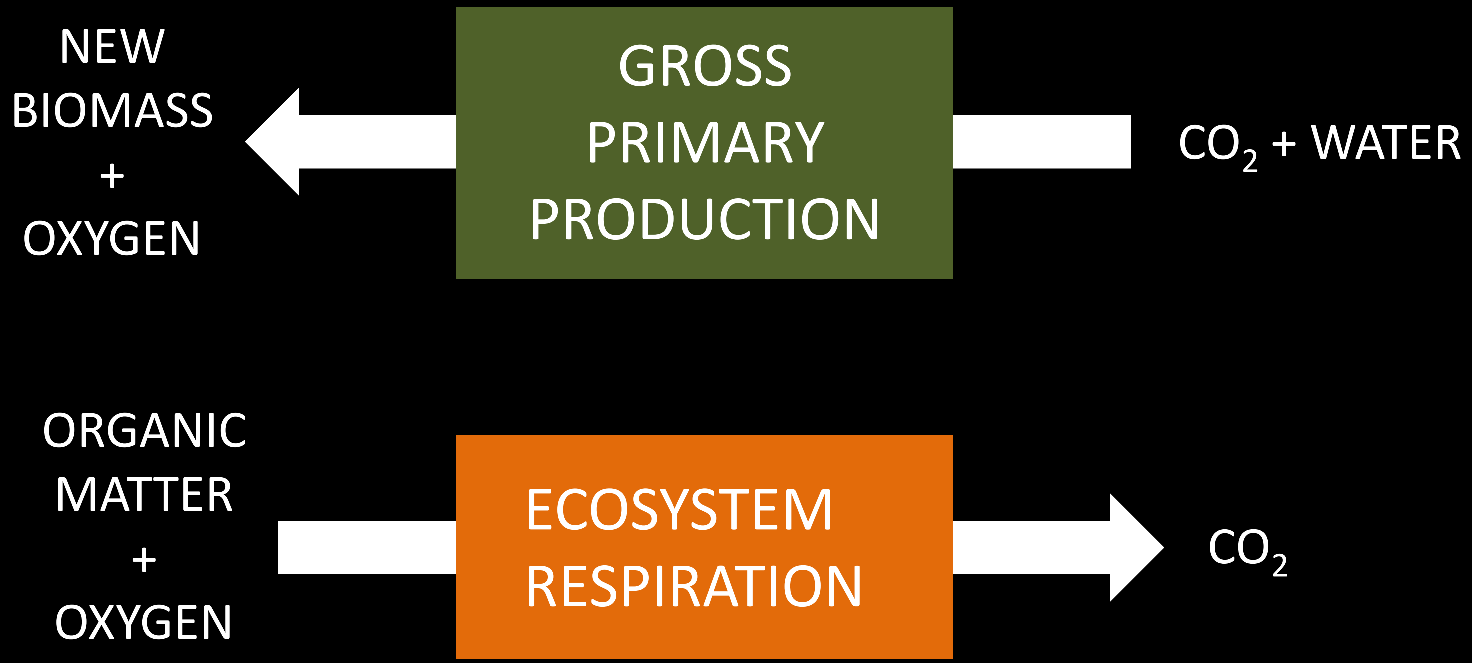
# Streamflow during summer



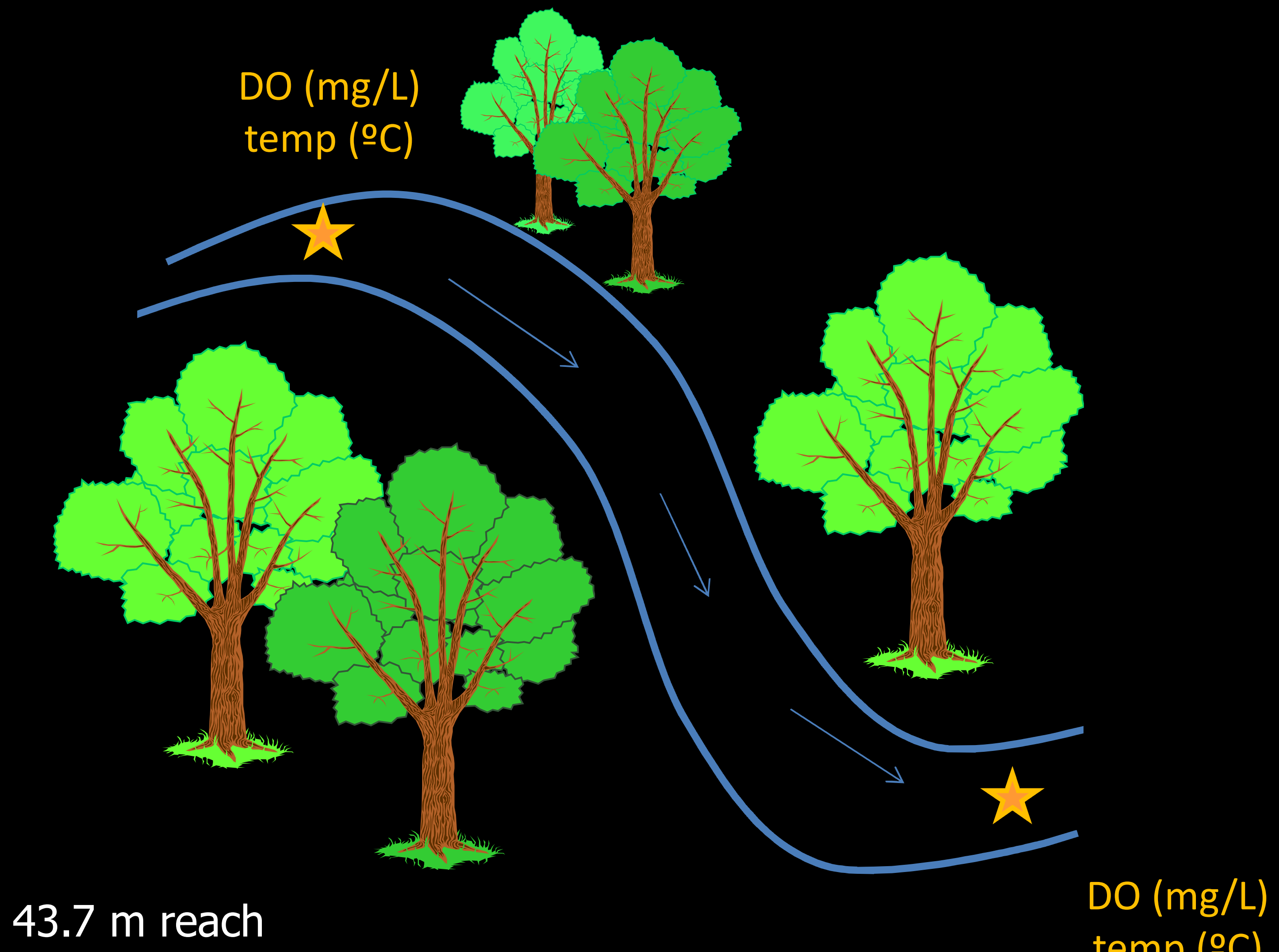
# Stream metabolic activity

Objective: test the effects of streamflow fluctuations on stream metabolism

Integrative measure of stream function



# methods: primary production and respiration



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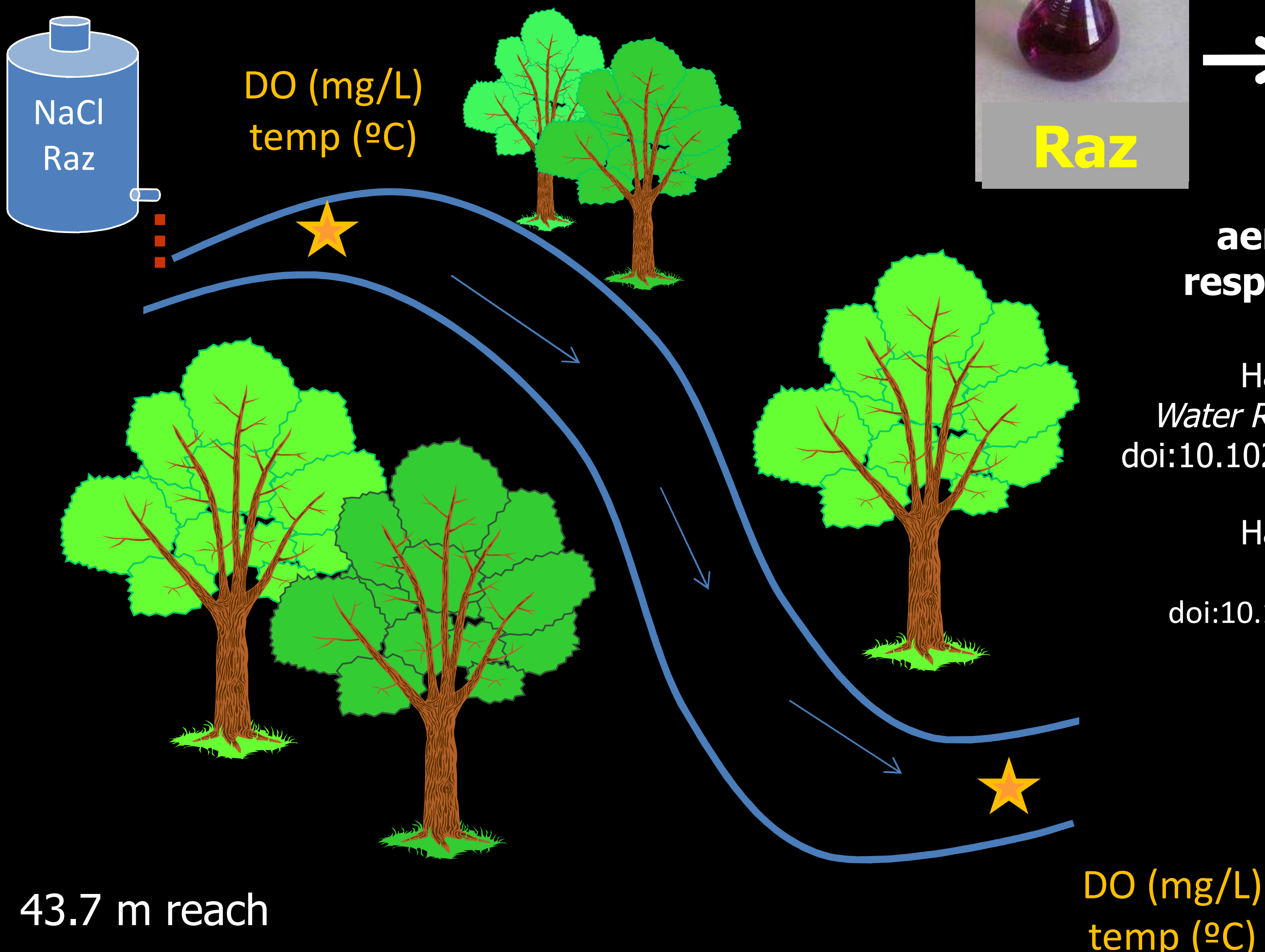
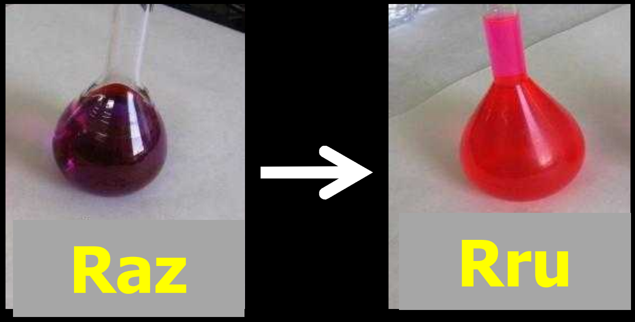


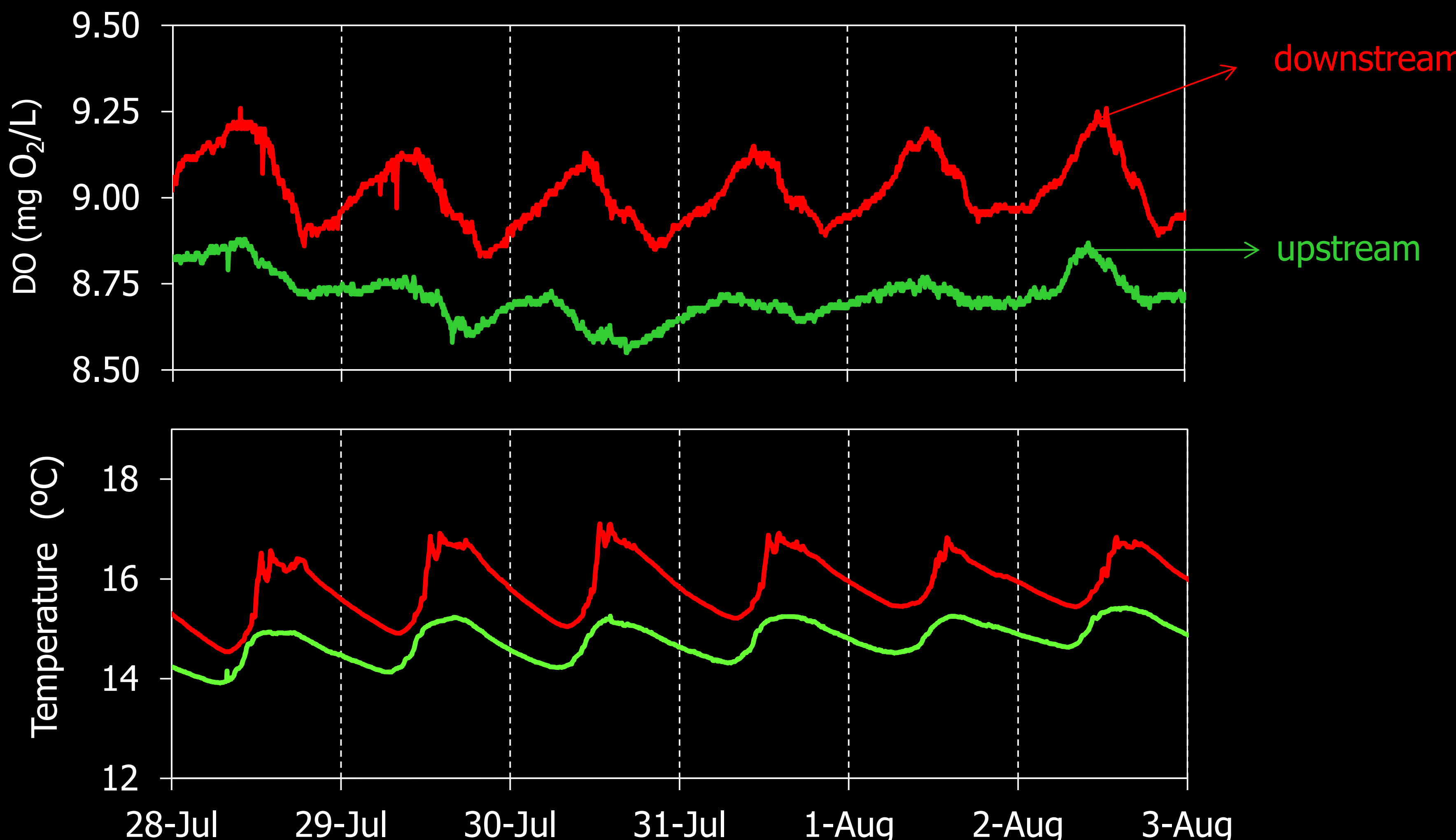




**aerobic respiration**

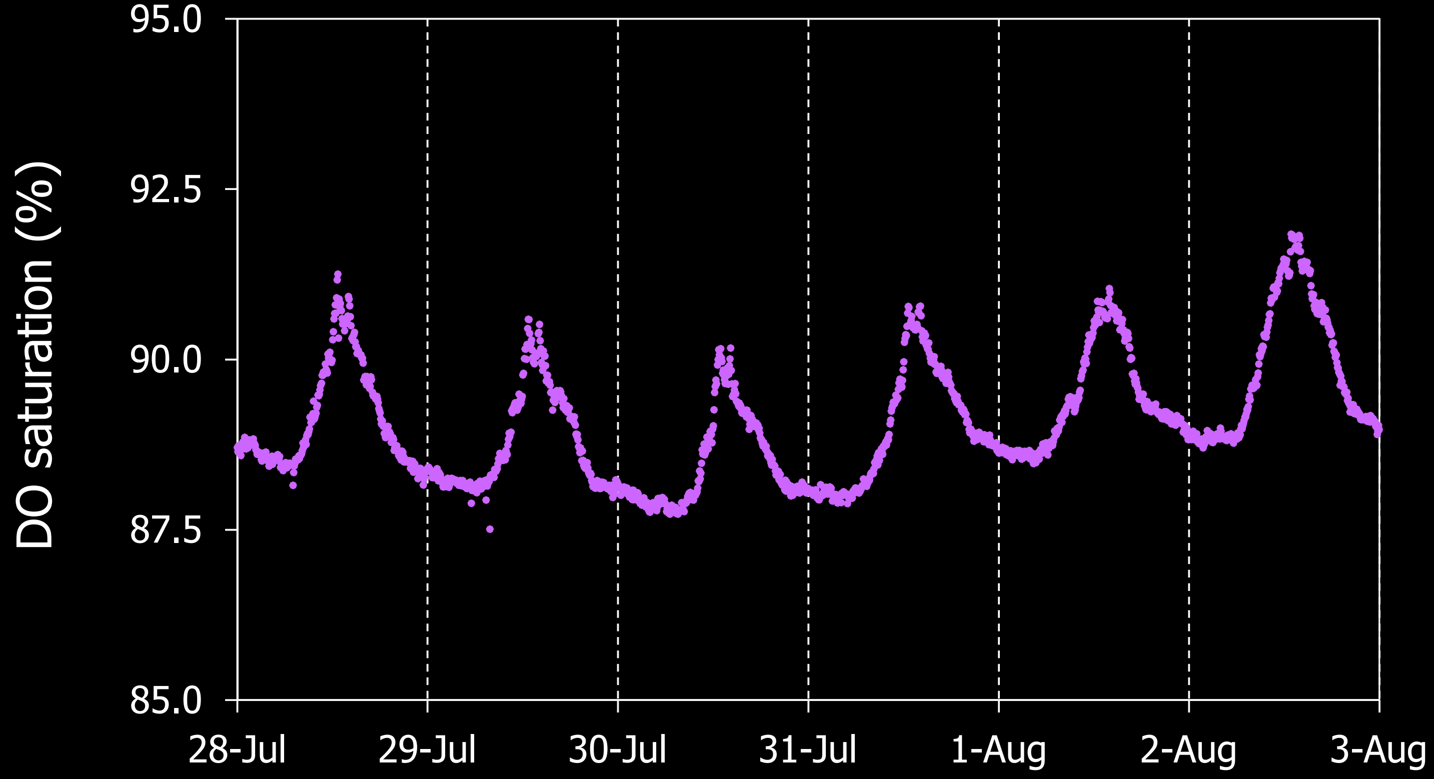
Haggerty et al. 2008
*Water Resources Research*
doi:10.1029/2007WR006670

Haggerty et al. 2009
*JGR: Biogesciences*
doi:10.1029/2008JG000942

# methods: primary production and respiration

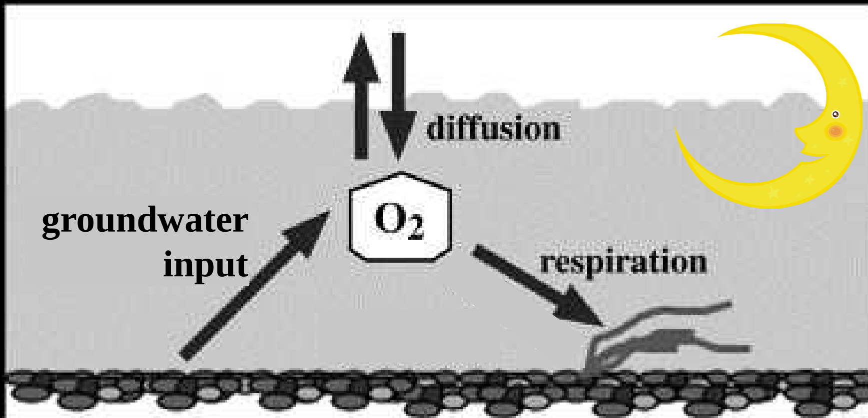


## methods: primary production and respiration




Maximum saturation aprox after noon
Minimum saturation, before dawn

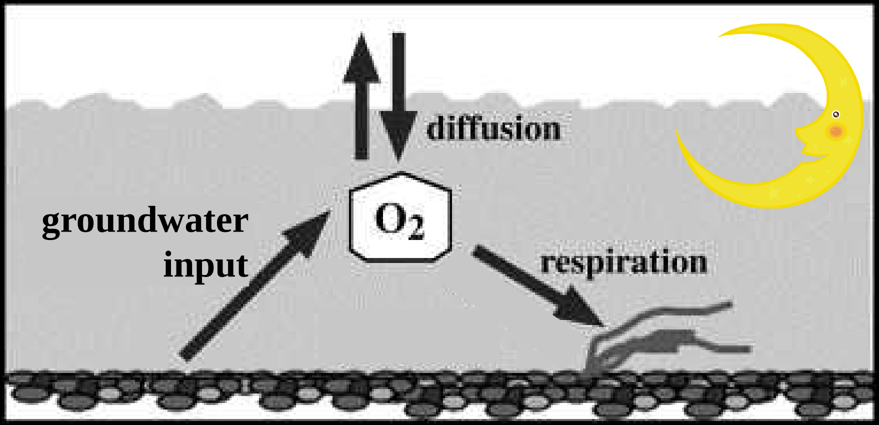
# methods: primary production and respiration



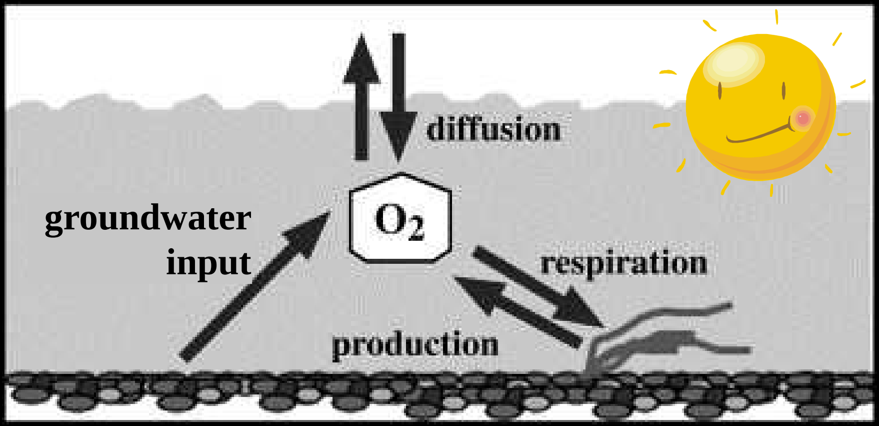

$$dC/dt = -ER \pm K(C_s - C) \pm A$$

Basic oxygen model for open-channel methods (adapted from Izaguirre et al. 2007)

# methods: primary production and respiration



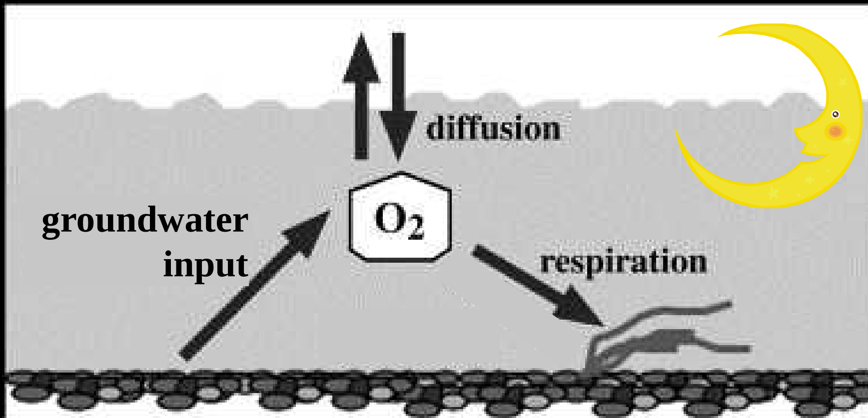

$$dC/dt = -ER \pm K(C_s - C) \pm A$$



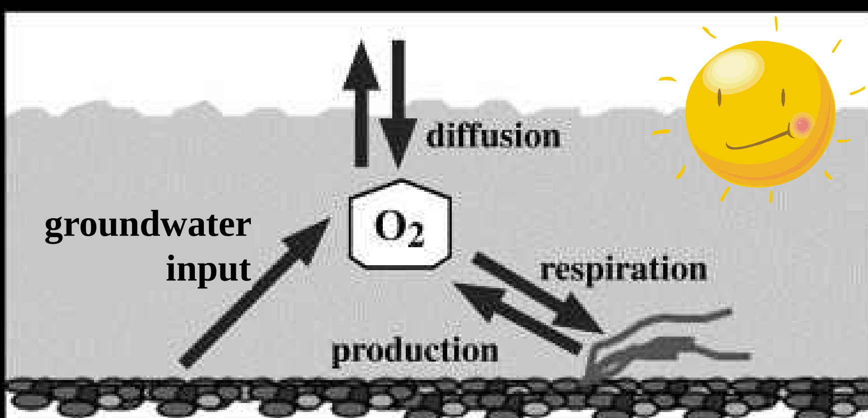

$$dC/dt = GPP(dt) - ER \pm K(C_s - C) \pm A$$

Basic oxygen model for open-channel methods (adapted from Izaguirre et al. 2007)

# methods: primary production and respiration




$$dC/dt = -ER \pm K(C_s - C) \pm A$$

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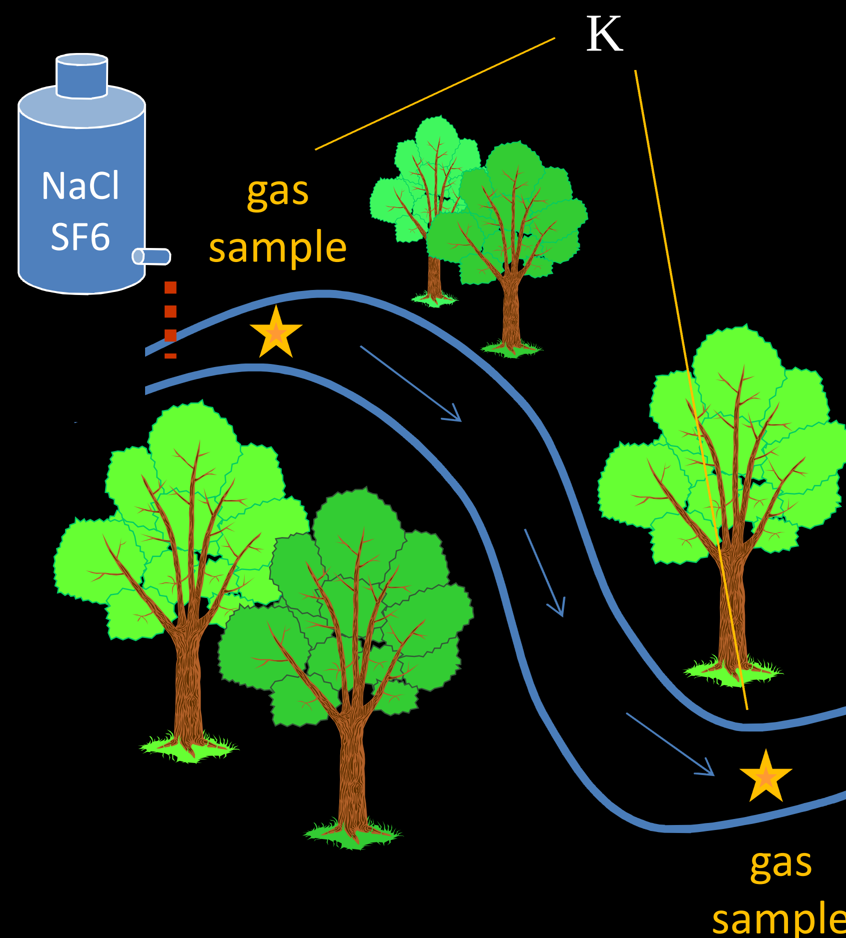
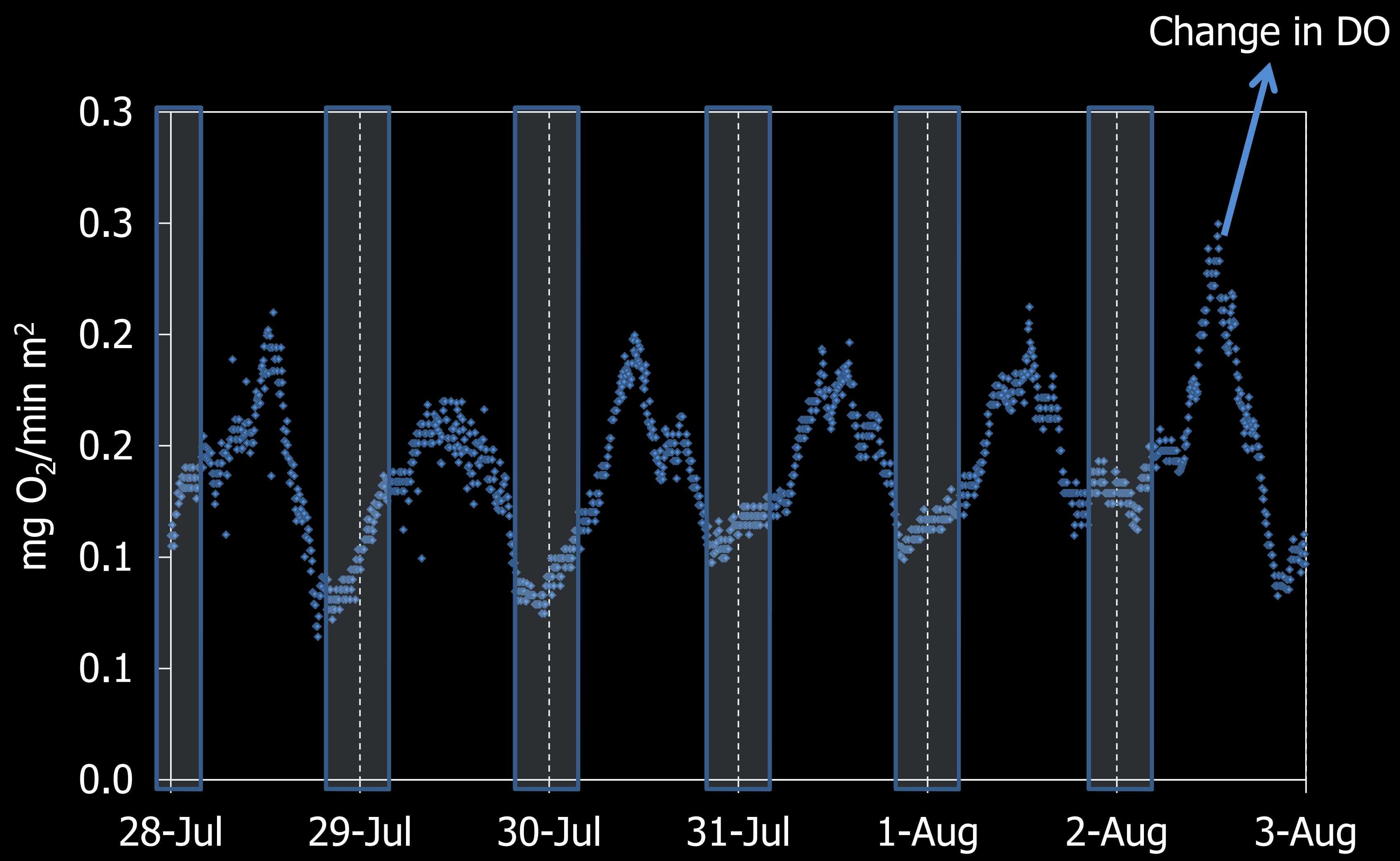
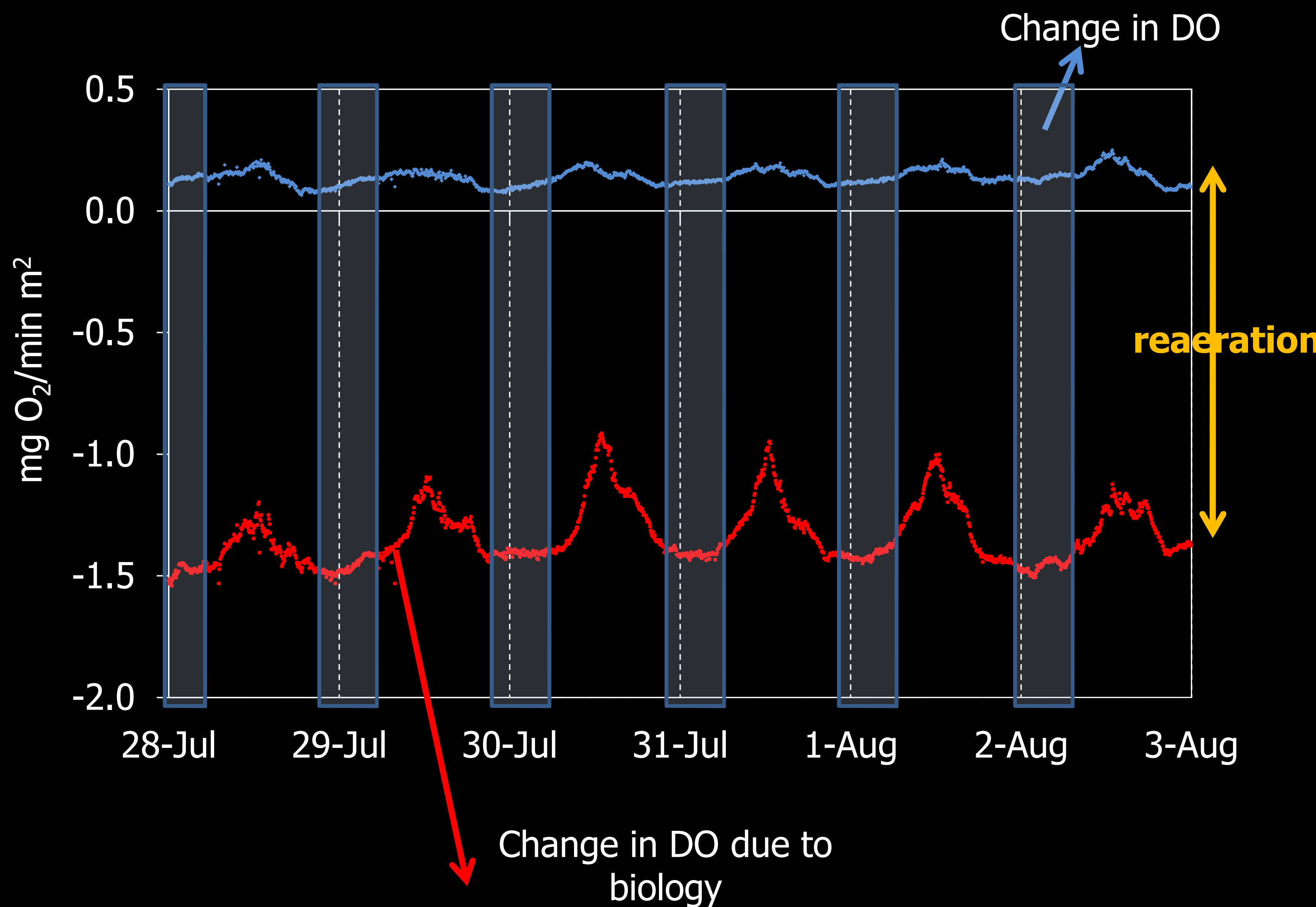



Basic oxygen model for open-channel methods (adapted from Izaguirre et al. 2007)

## results: change in DO



# results: change in DO



## results: change in DO

| | Ecosystem respiration (ER) (g O2/m2 day) | Gross primary production (GPP) (g O2/m2 day) |
|---|---|---|
| 7/28/2009 | -2.35 | 0.15 |
| 7/29/2009 | -2.42 | 0.16 |
| 7/30/2009 | -2.46 | 0.15 |
| 7/31/2009 | -2.40 | 0.17 |
| 8/1/2009 | -2.27 | 0.14 |
| **Avg** | **-2.36** | **0.15** |

# assumptions

Constant streamflow

Q= 0.42 L/s

Constant travel time (43.7 meters)

92 minutes

Constant contribution of hyporheic water

Constant wetted area

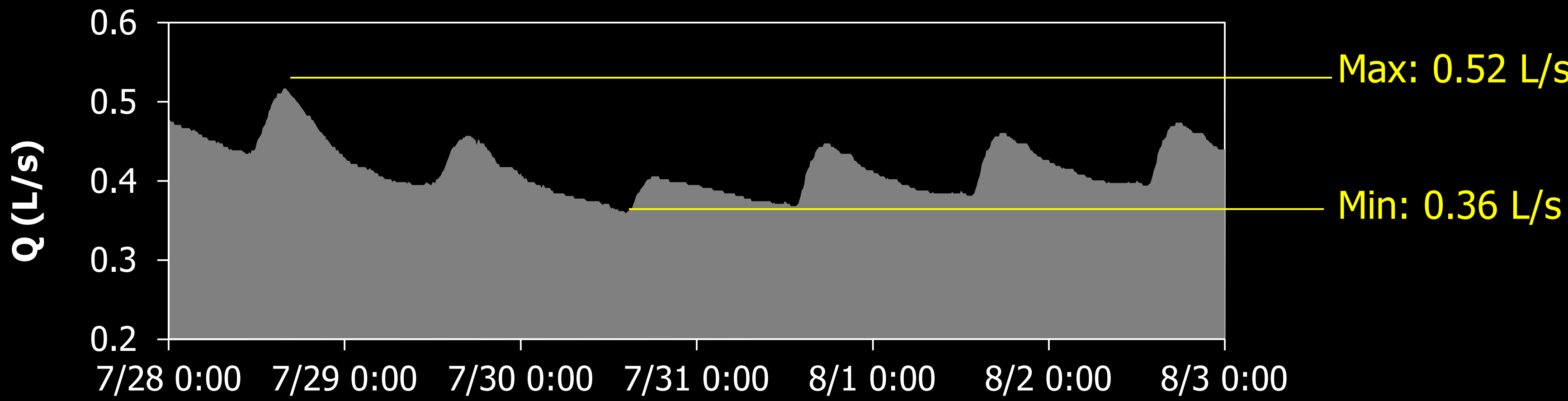
A= 45.9 $m^2$

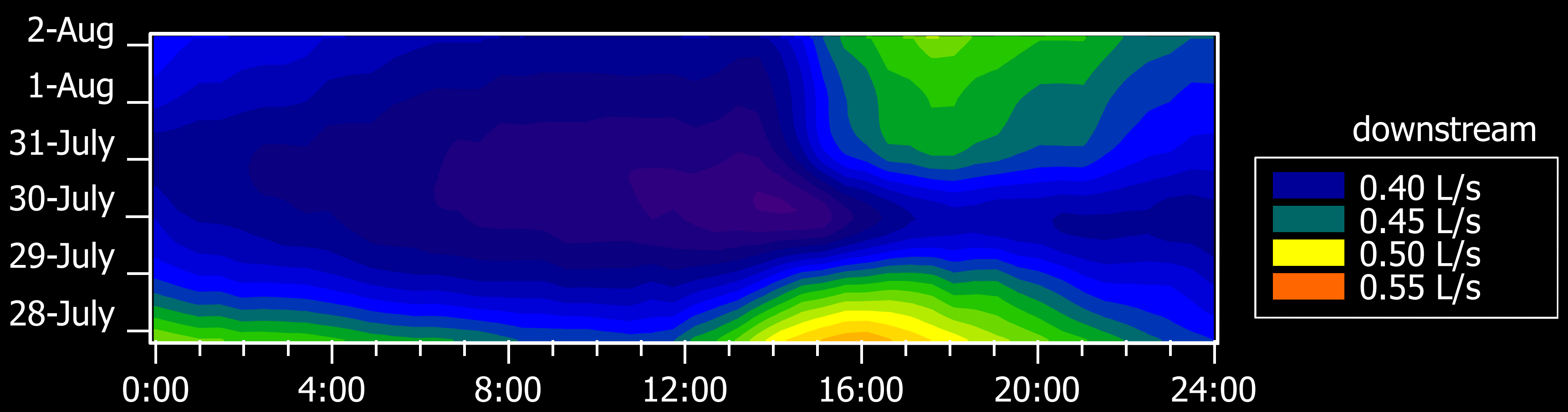
| (g O2/m2 day) | ER | GPP |
|---|---|---|
| Constant Q | -2.36 | 0.15 |

# results

Constant streamflow Q= 0.42 L/s

| (g O2/m2 day) | ER | GPP |
|---|---|---|
| Constant Q | -2.36 | 0.15 |

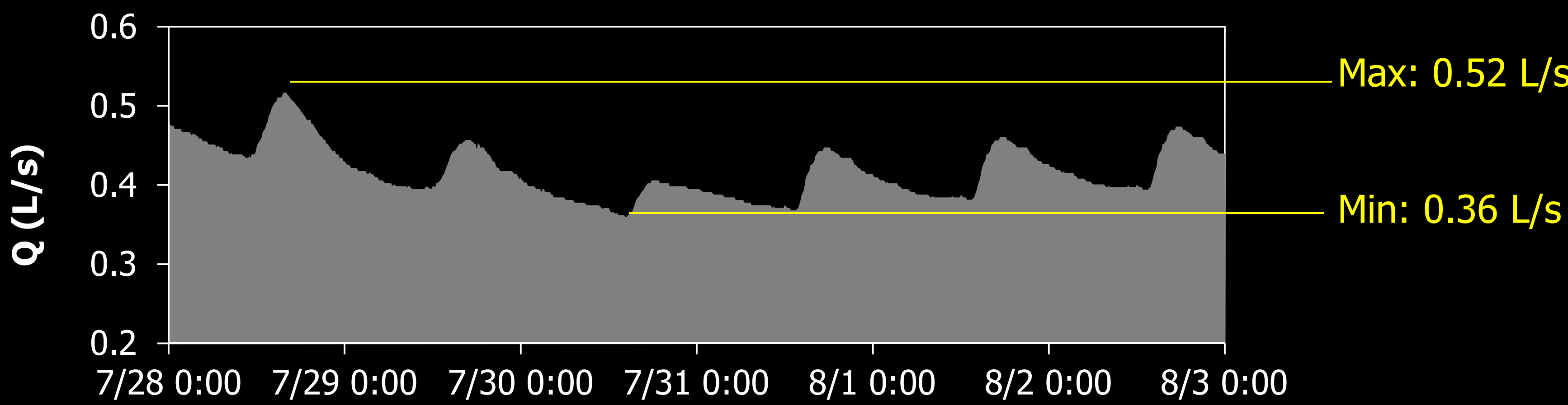


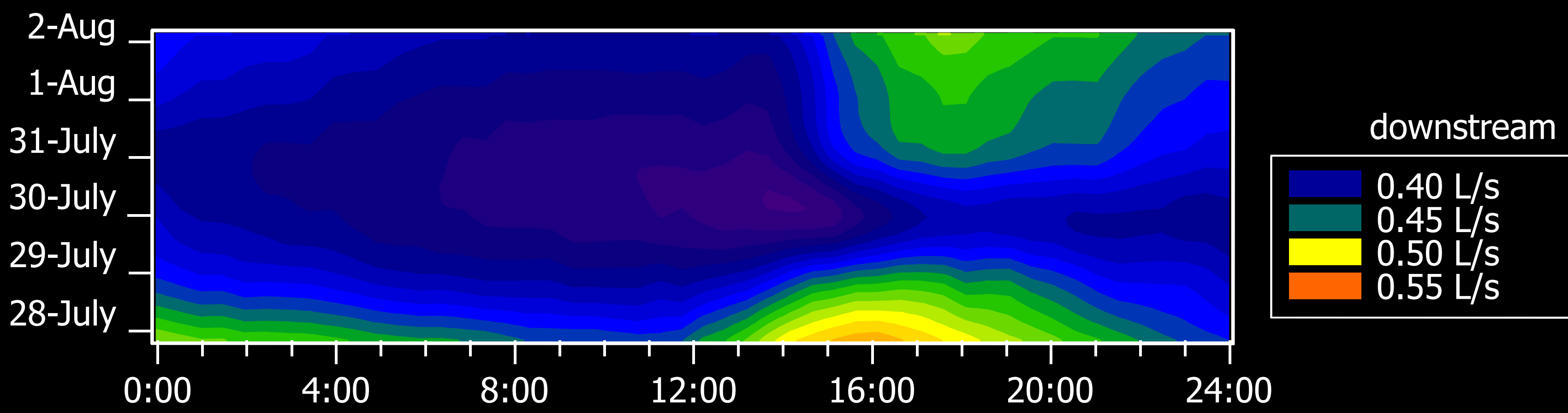



# results

Constant streamflow | Q= 0.42 L/s
Q= 0.36-0.52 L/s

| (g O2/m2 day) | ER | GPP |
|---|---|---|
| Variable Q | -2.55 | 0.17 |



# results

Constant streamflow Q= 0.42 L/s
Q= 0.36-0.52 L/s

Constant travel time (43.7 meters)
92 minutes

| (g O2/m2 day) | ER | GPP |
|---|---|---|
| Variable Q | **-2.55** | **0.17** |

# results

Constant streamflow

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Q= 0.36-0.52 L/s

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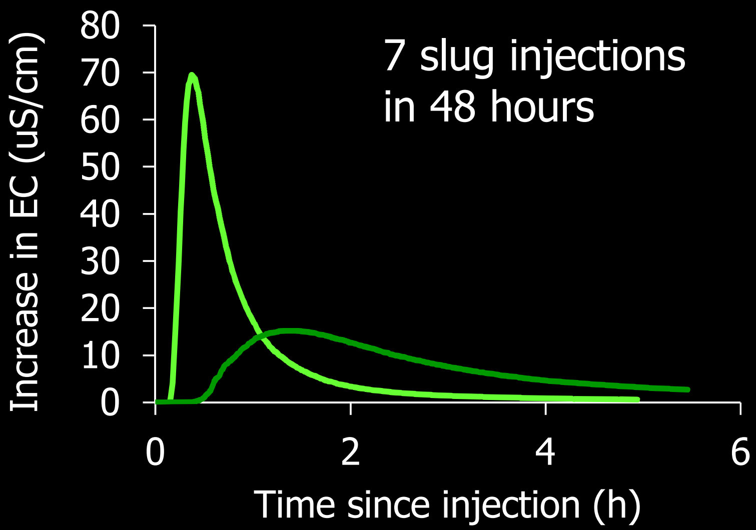
Constant travel time (43.7 meters)

92 minutes



# results

Constant streamflow

Q= 0.42 L/s

Q= 0.36-0.52 L/s

| (g O2/m2 day) | ER | GPP |
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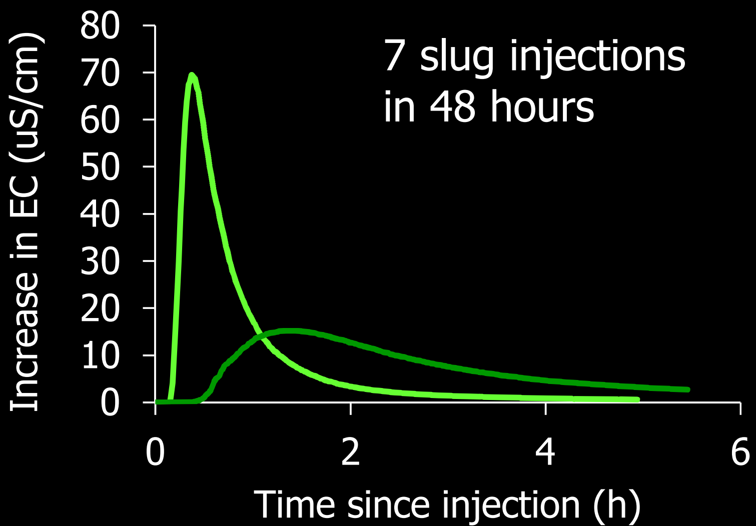
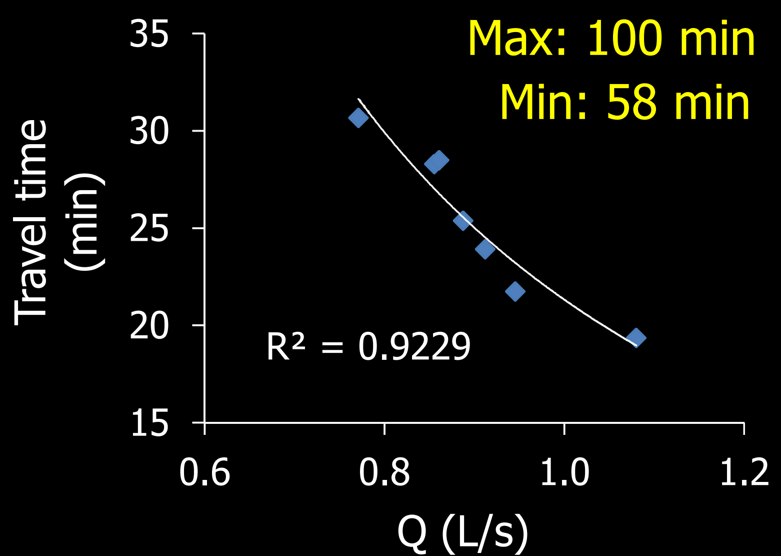
| Variable Q | -2.55 | 0.17 |

Constant travel time (43.7 meters)

92 minutes

58-100 min



# results

Constant streamflow

Q= 0.42 L/s

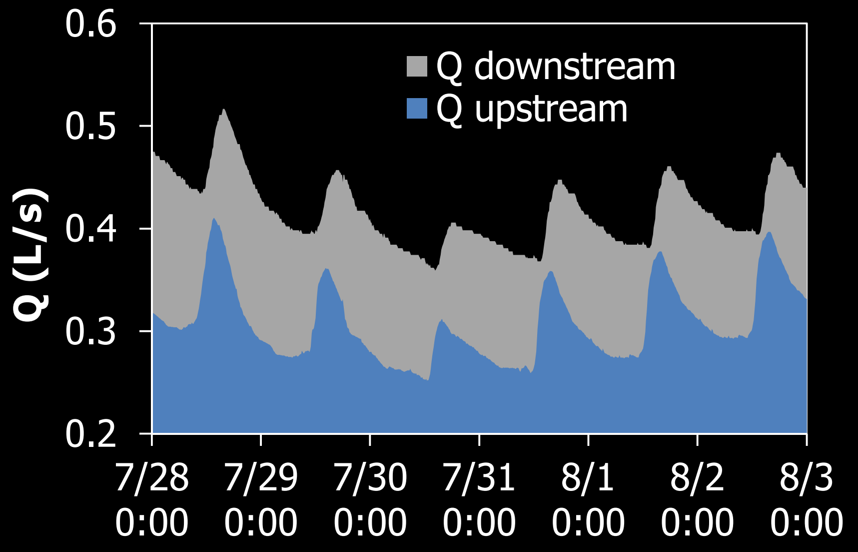
Q= 0.36-0.52 L/s

Constant travel time (43.7 meters)

92 minutes

58-100 min

Constant contribution of hyporheic water



# results

Constant streamflow

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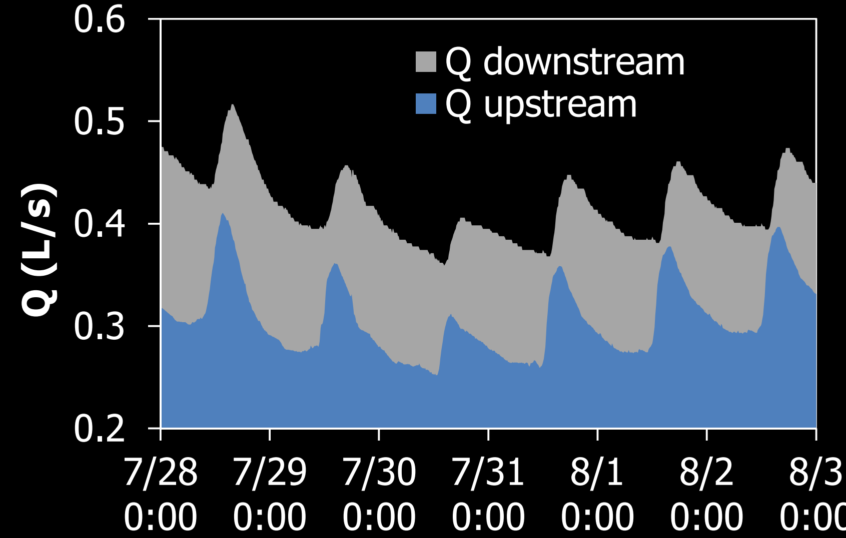
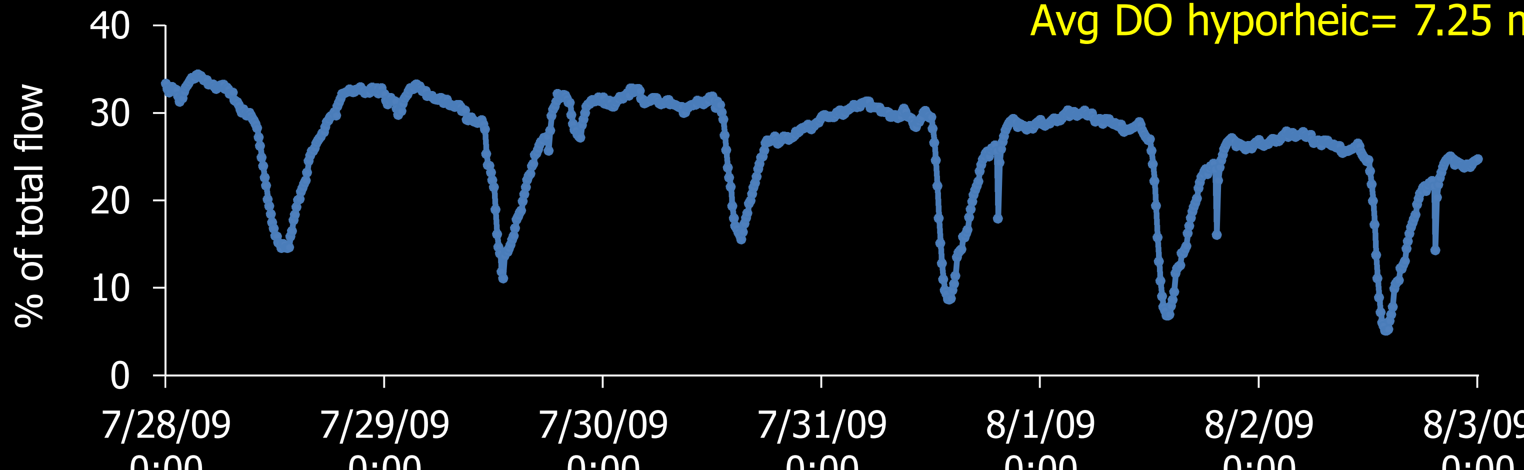
58-100 min

Constant contribution of hyporheic water




Avg DO surf= 8.87 mg $O_2$/L

Avg DO hyporheic= 7.25 mg $O_2$/L



# results

Constant streamflow

Q= 0.42 L/s

Q= 0.36-0.52 L/s

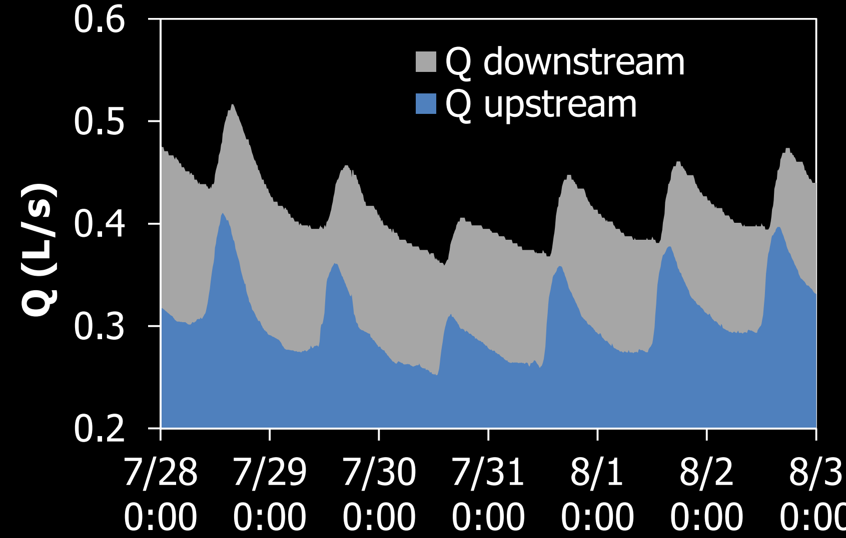
Constant travel time (43.7 meters)

92 minutes

58-100 min

Constant contribution of hyporheic water

5-34%

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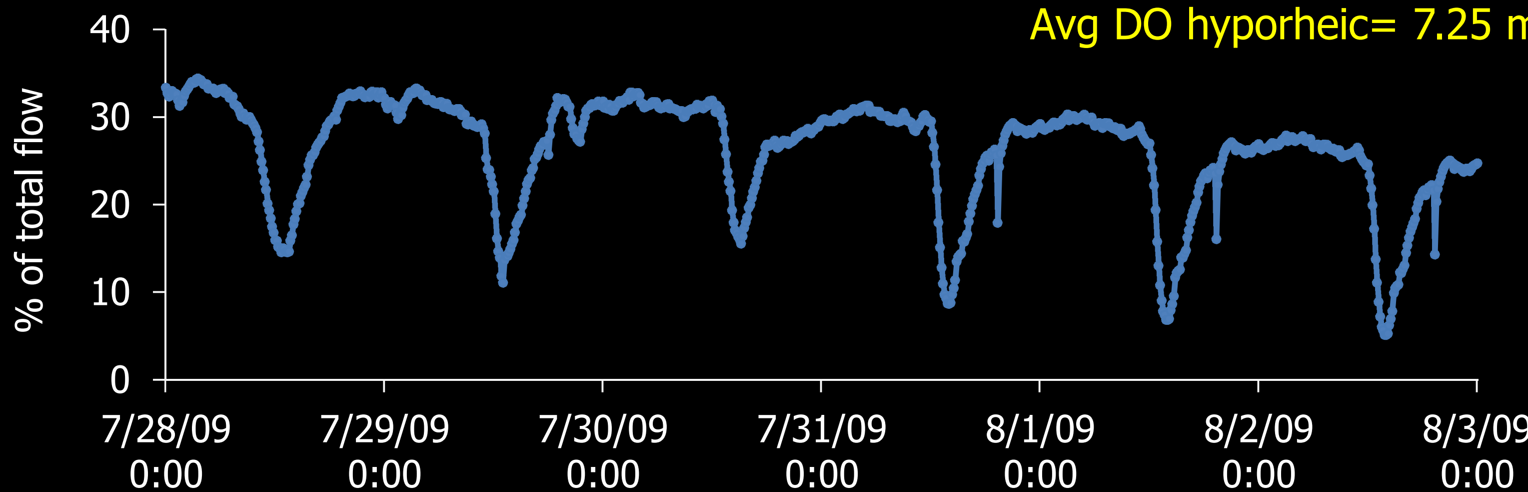

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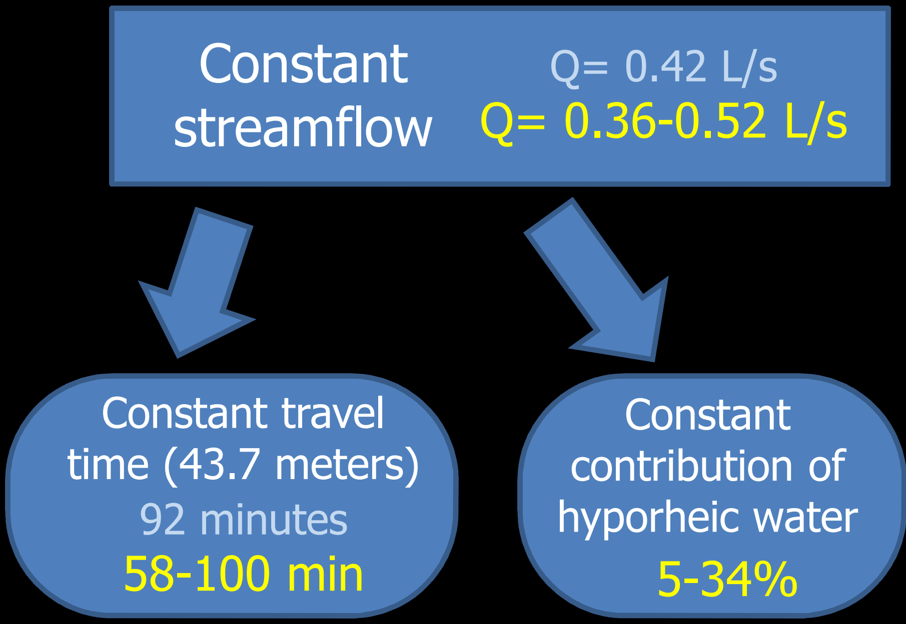



| (g O2/m2 day) | ER | GPP |
|---|---|---|
| Hyporheic water | -2.20 | 0.14 |

# results

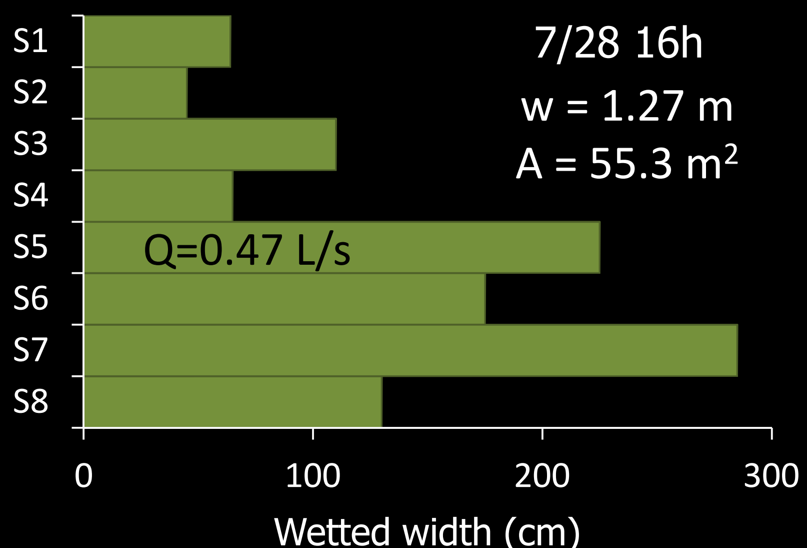
Constant streamflow
Q= 0.42 L/s
Q= 0.36-0.52 L/s

| (g O2/m2 day) | ER | GPP |
|---|---|---|
| Hyporheic water | -2.20 | 0.14 |

Constant travel time (43.7 meters)
92 minutes
58-100 min

Constant contribution of hyporheic water
5-34%

Constant wetted area
A= 45.9 $m^2$



# results

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|---|---|---|
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58-100 min

Constant contribution of hyporheic water
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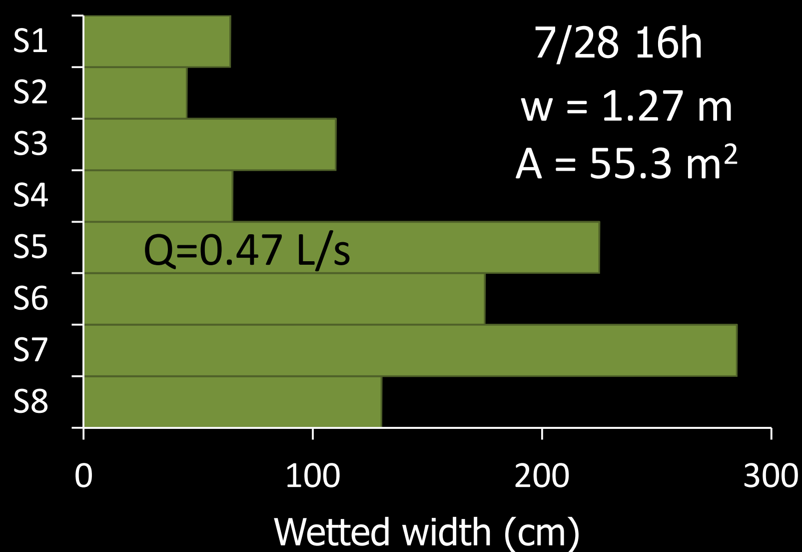
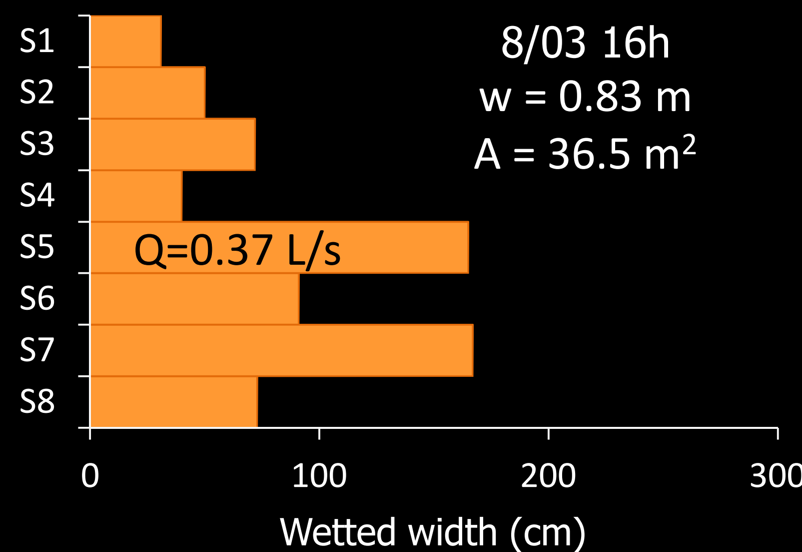


# results

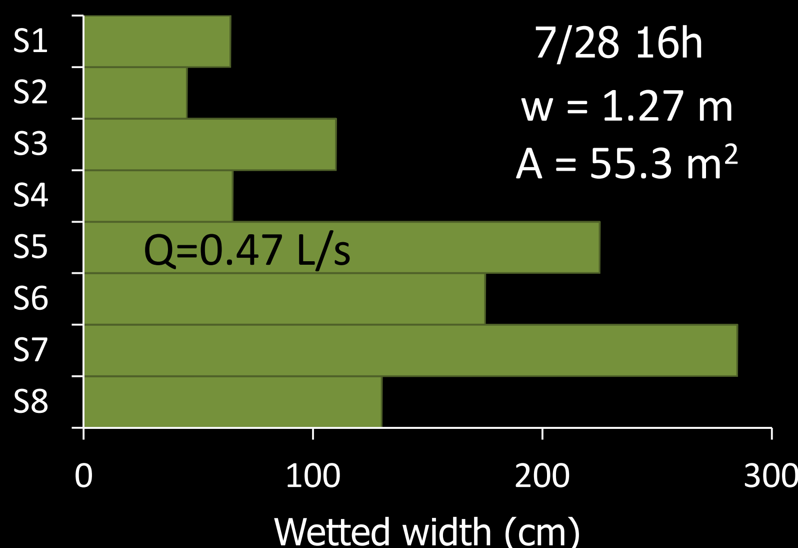
| (g O2/m2 day) | ER | GPP |
|---|---|---|
| Variable A | -1.82 to -3.20 | 0.11 to 0.21 |

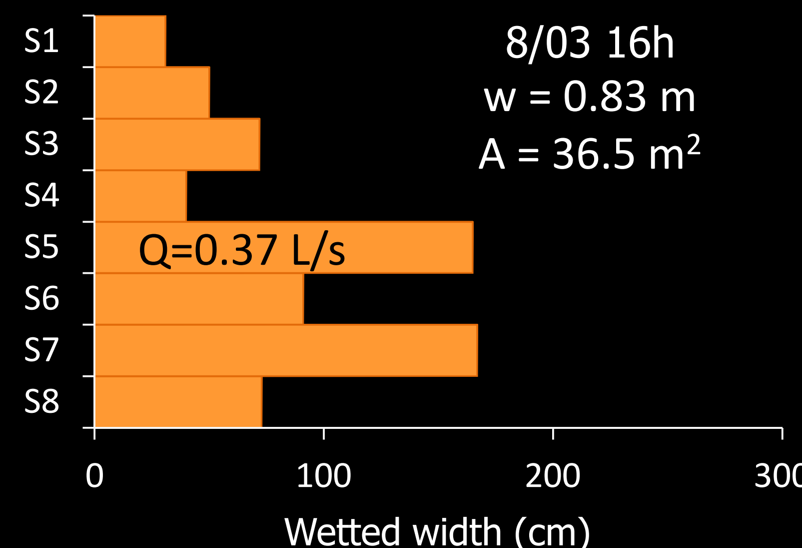
**Constant streamflow**
Q= 0.42 L/s
Q= 0.36-0.52 L/s

**Constant travel time (43.7 meters)**
92 minutes
58-100 min

**Constant contribution of hyporheic water**
5-34%

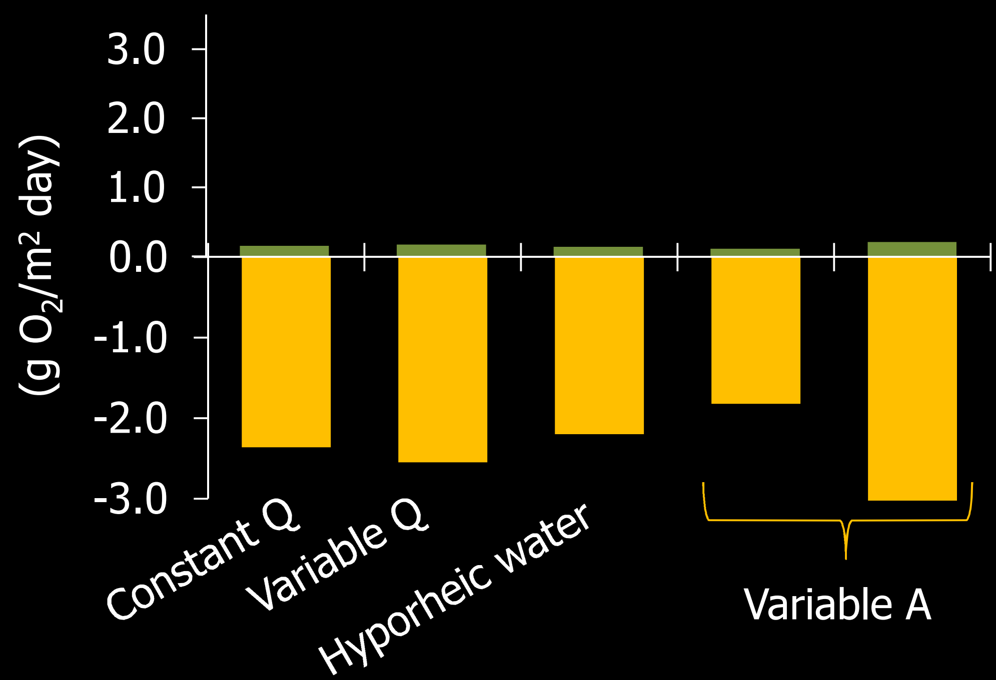
**Constant wetted area**
A= 45.9 $m^2$
A=36.5-55.3 $m^2$



# results

| ($g\ O_2/m^2$ day) | ER | GPP |
|---|---|---|
| Constant Q | -2.36 | 0.15 |
| Variable Q | -2.55 | 0.17 |
| Hyporheic water | -2.20 | 0.14 |
| Variable A | -1.82 to -3.20 | 0.11 to 0.21 |



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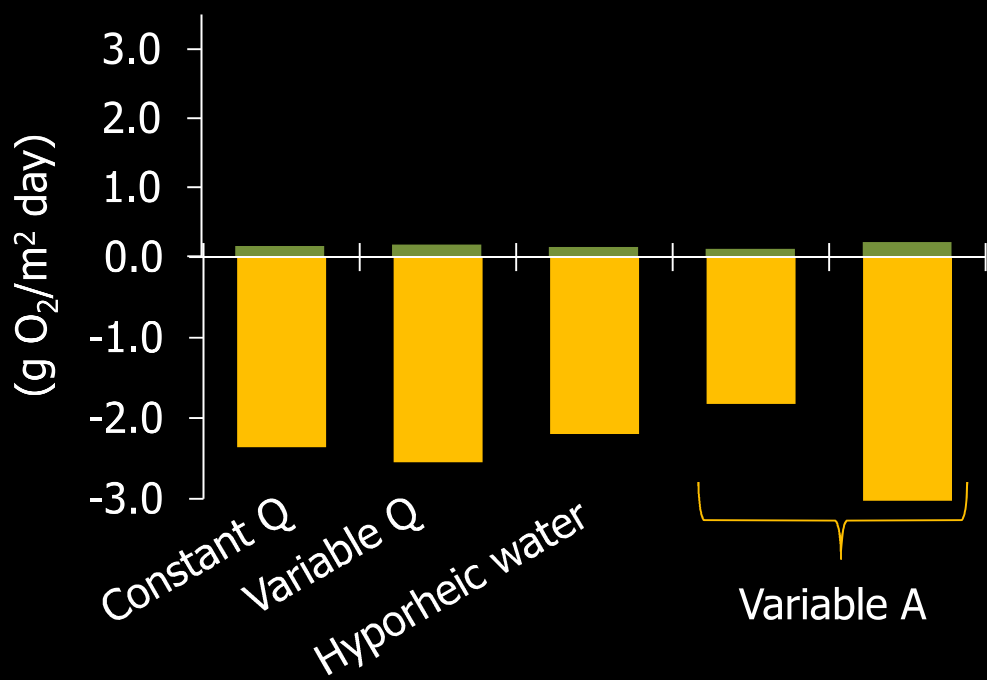


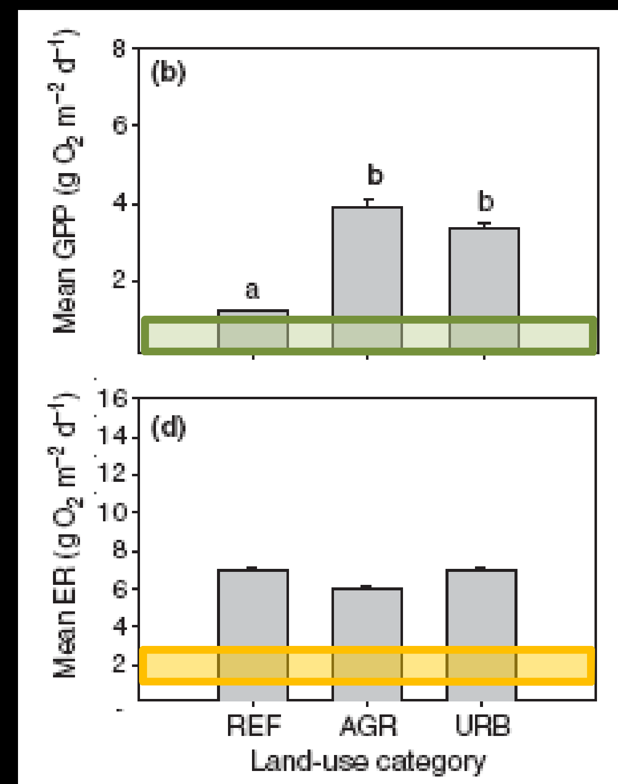


Bernot et al. 2010. Freshwater Biology, 55.

# conclusions

## Diel variation in streamflow influences stream metabolism by affecting:

Water travel time, and consequently, the amount of diffused $O_2$ from the atmosphere between the upstream and downstream sites.

The amount of dissolved $O_2$ transported downstream per unit of time, and also the supply of nutrients and o.m.

The contribution of hyporheic water to total streamflow

Wetted area, habitat availability

OTHER SYSTEMS, WITH MORE ANOXIA???

**Diel variation in streamflow should be taken under consideration when measuring metabolic activity, specially under low flow conditions**