Impacts of PAH-contaminated sediment on early life history stages of benthic fish

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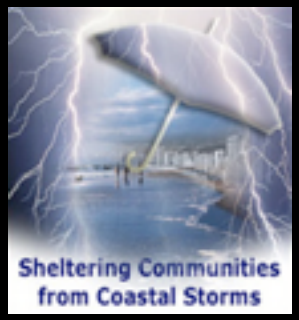
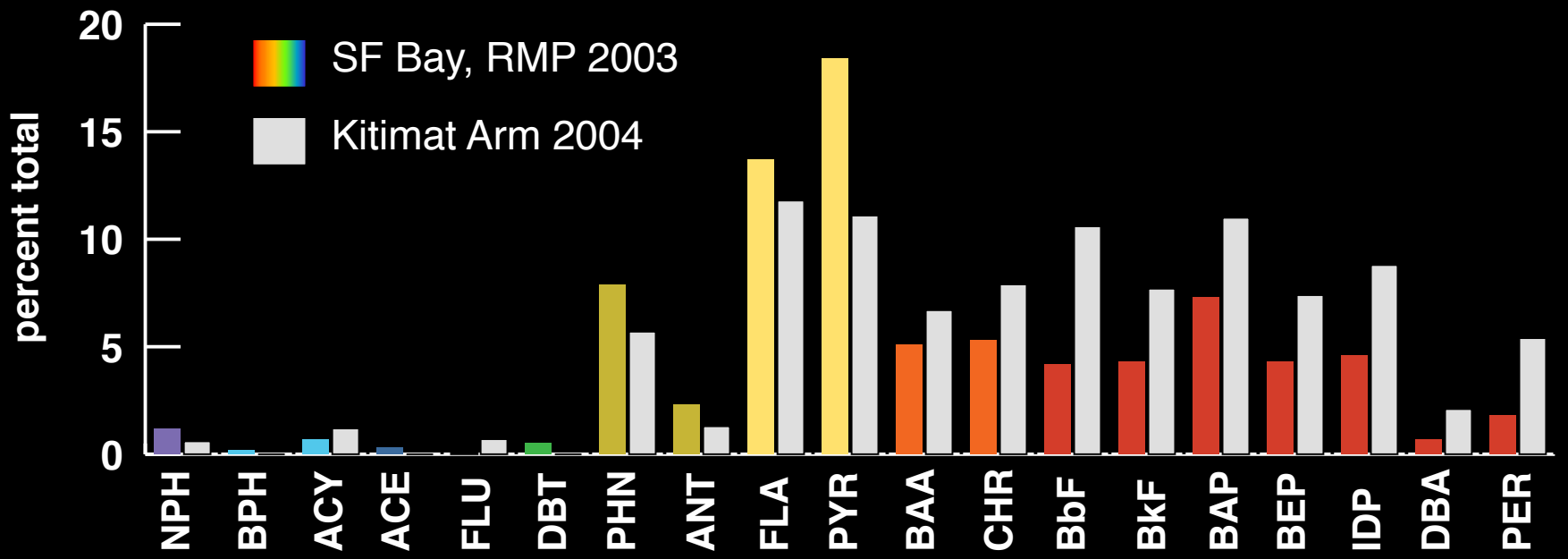


Screening high molecular weight PAHs



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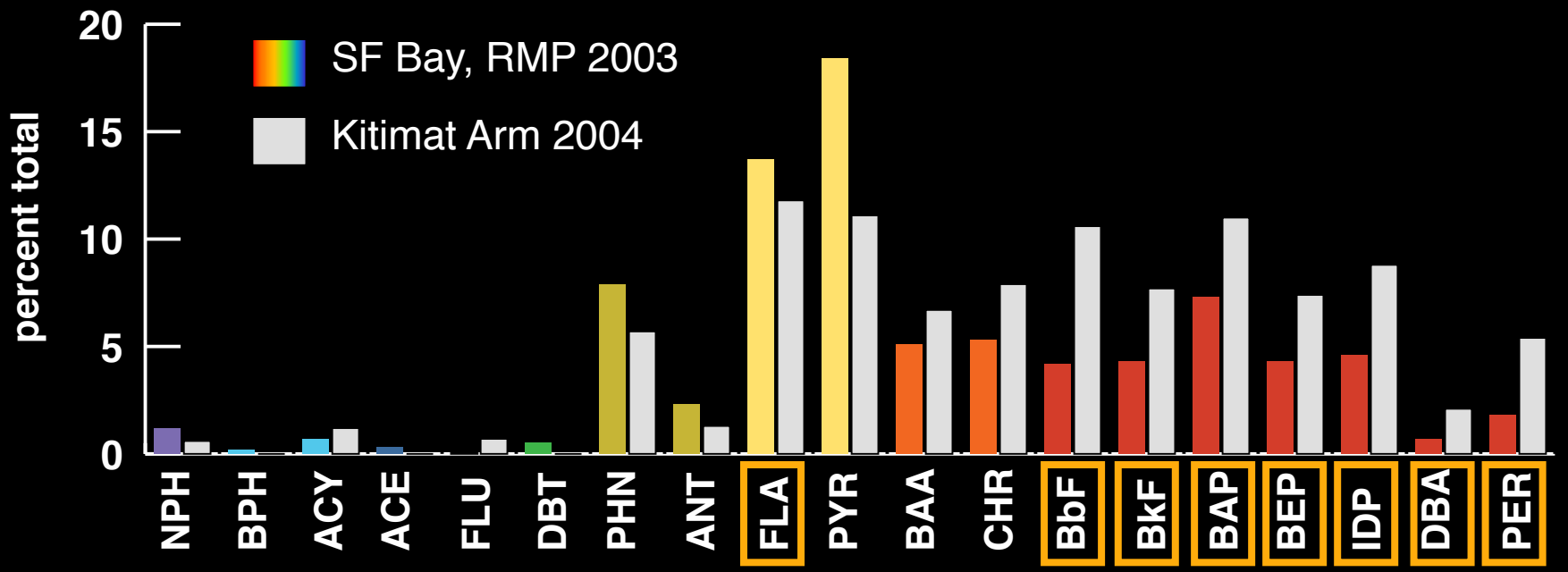
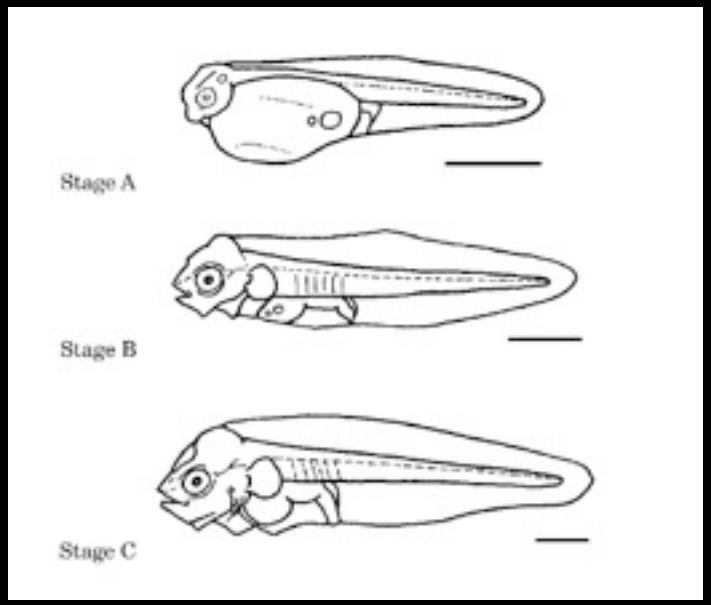
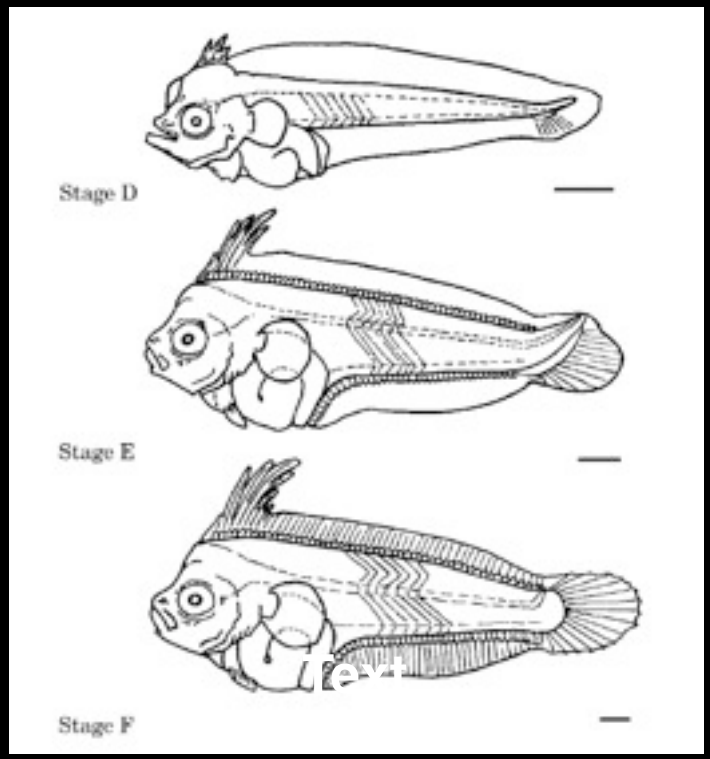


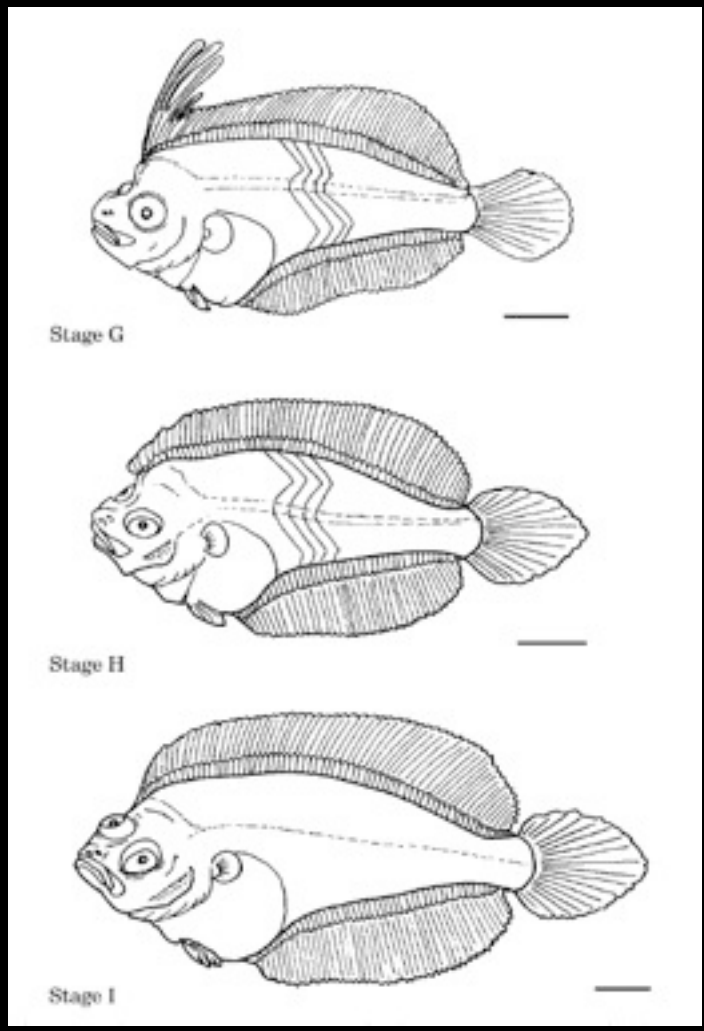
Kitimat PAH bioavailability estimates from stomach contents (PAHs in benthic prey)

	Puget Sound	Kitimat
juvenile salmon	15,000 ng/g	1500 ng/g
flatfish (English sole)	8000 ng/g	2000 ng/g

California halibut larval development and metamorphosis



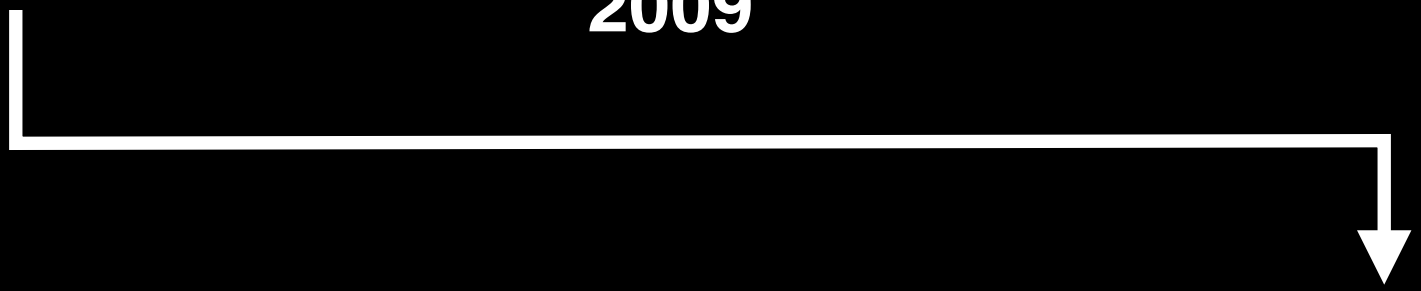




Los Pensaquitos Lagoon, San Diego

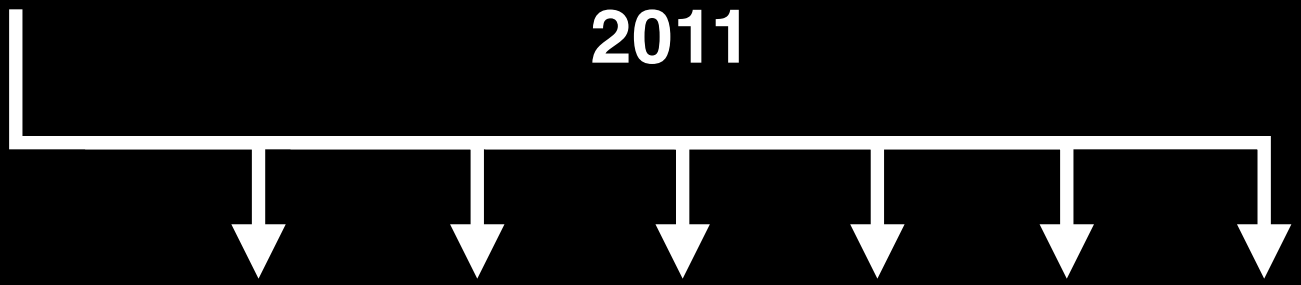
Experimental design

25 per tank, 3 tanks per dose,
3 ∑PAH levels + control



survival at 47 days

15 per tank, 6 tanks per dose,
4 ∑PAH levels + control

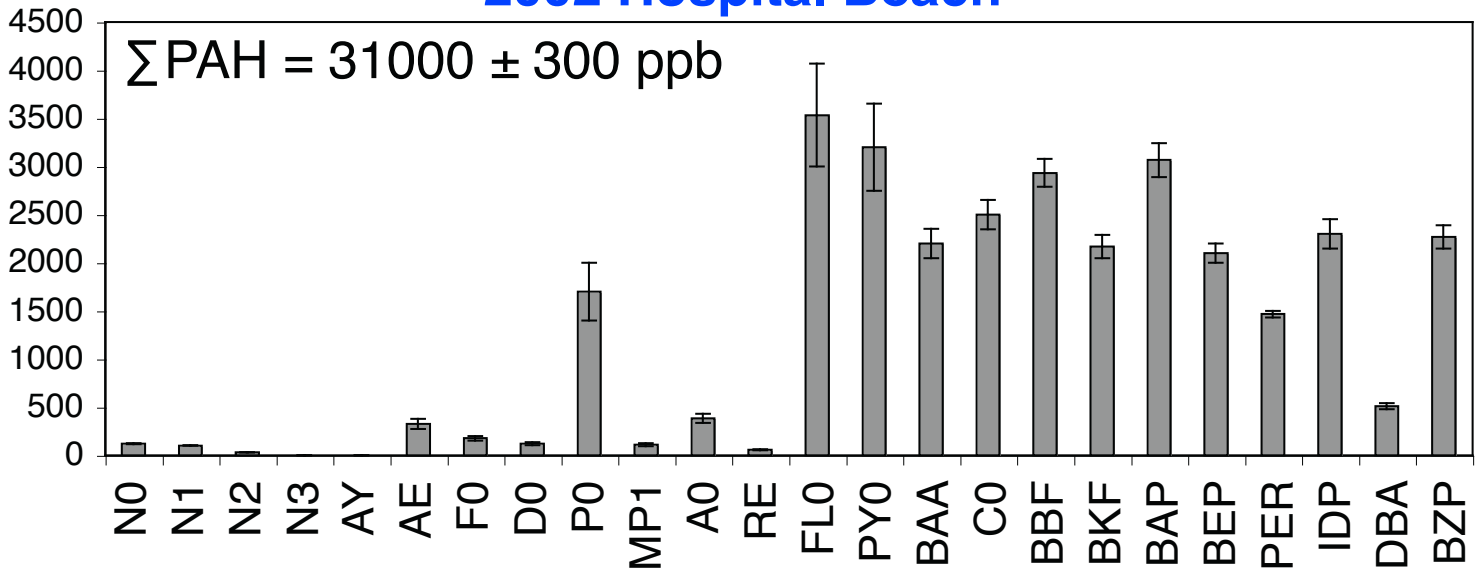


harvest weekly to 42 days

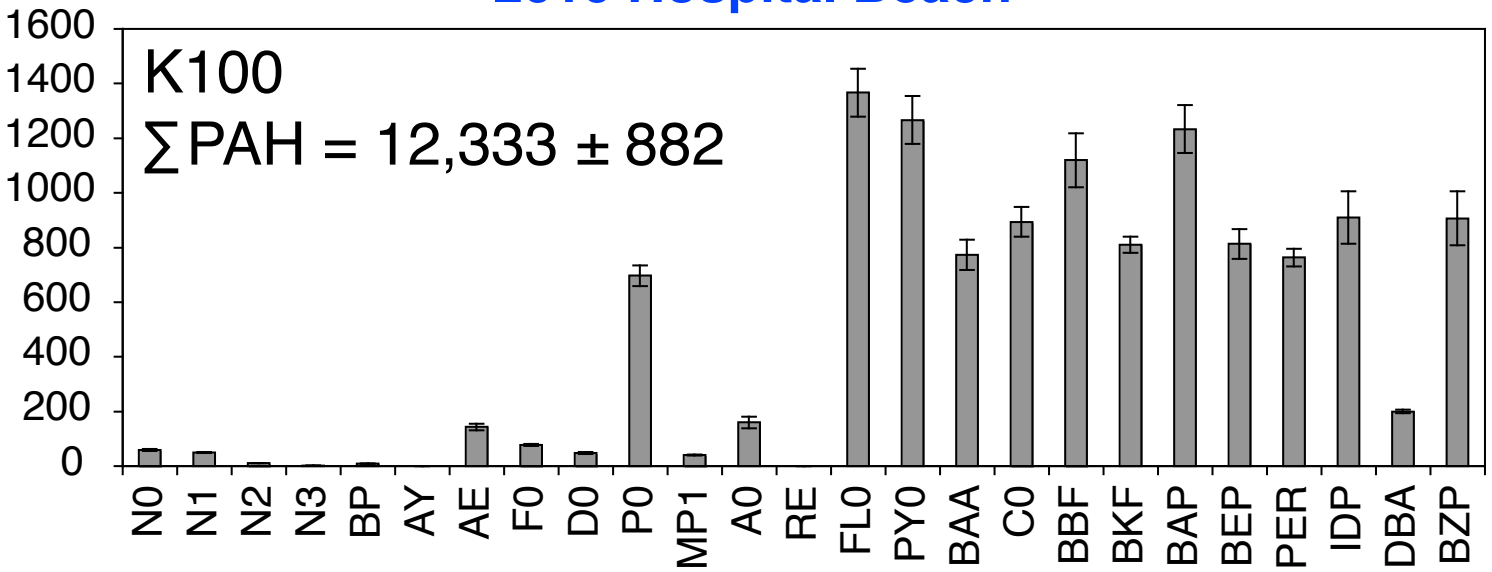
Experimental design

- 2009, clean and hot sediments mixed by hand in exposure tanks, allowed to settle
- 2011, clean and hot sediment homogenized as mud with a paint mixer, then distributed to tanks

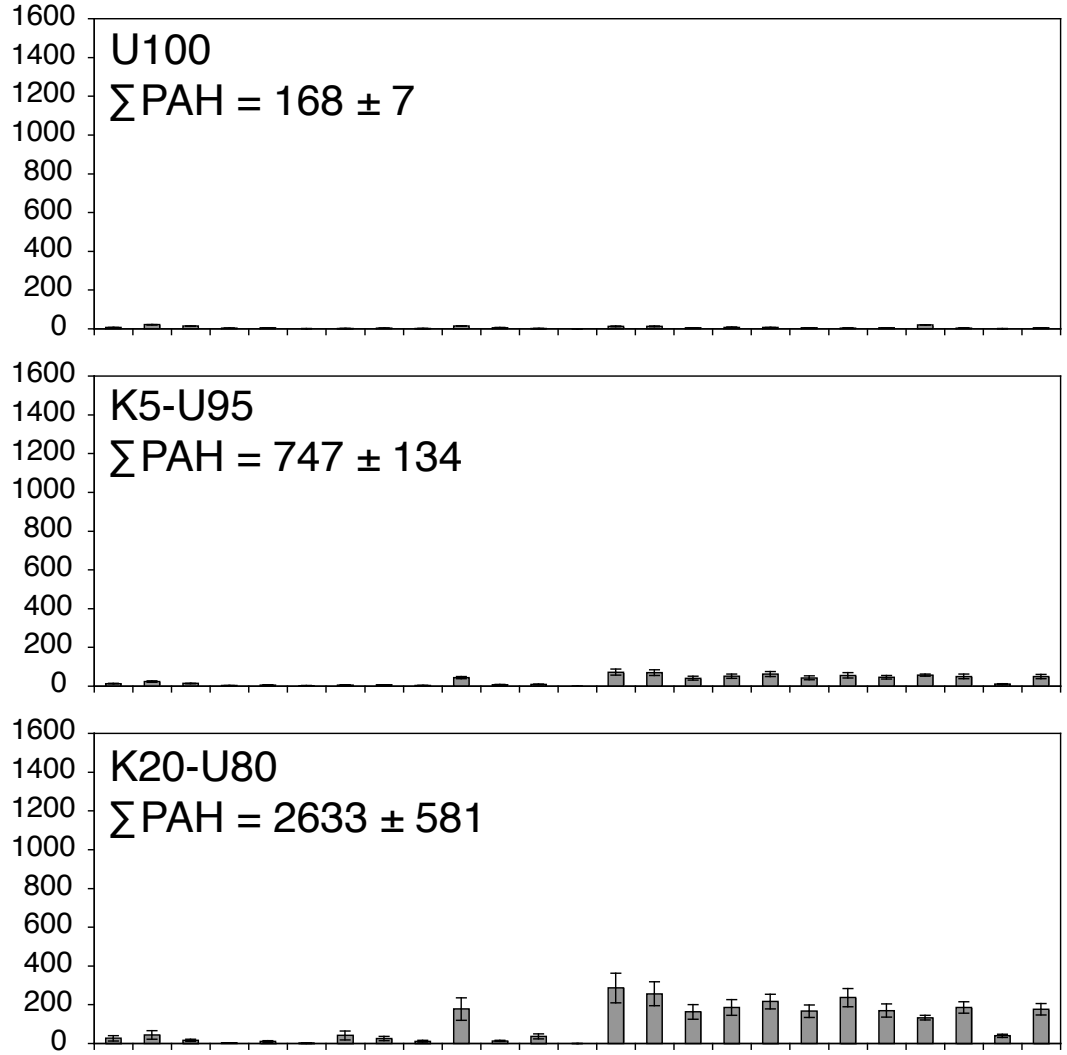
2002 Hospital Beach

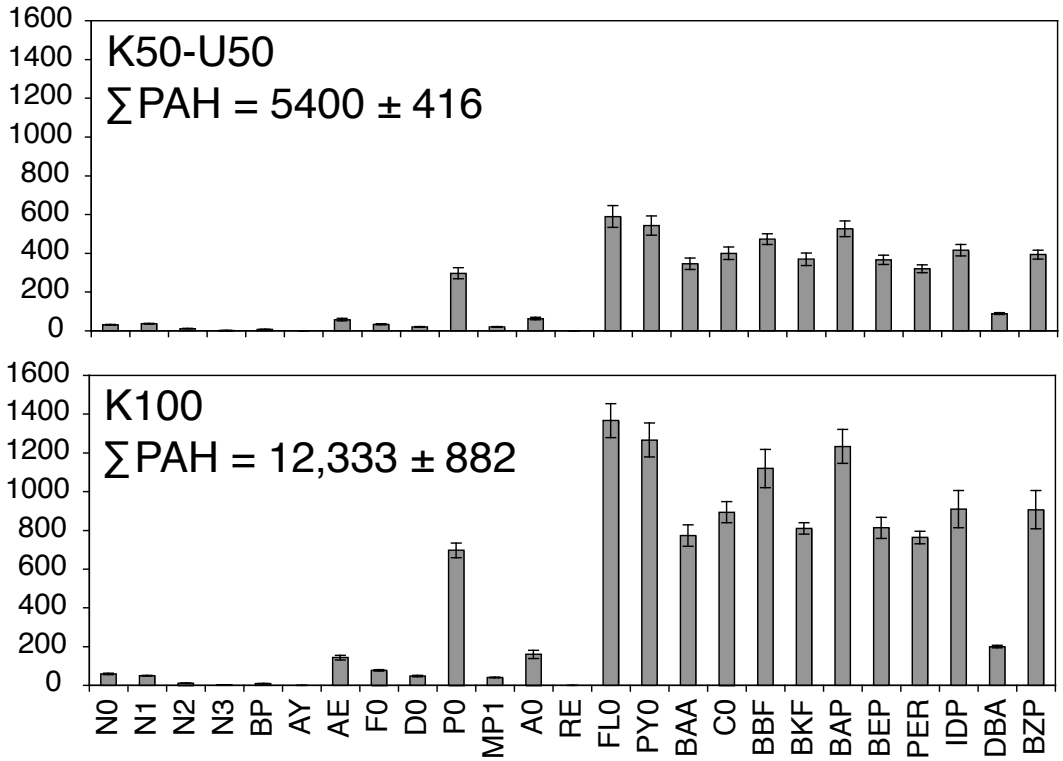


2010 Hospital Beach



Verification of PAHs in sediment dilutions



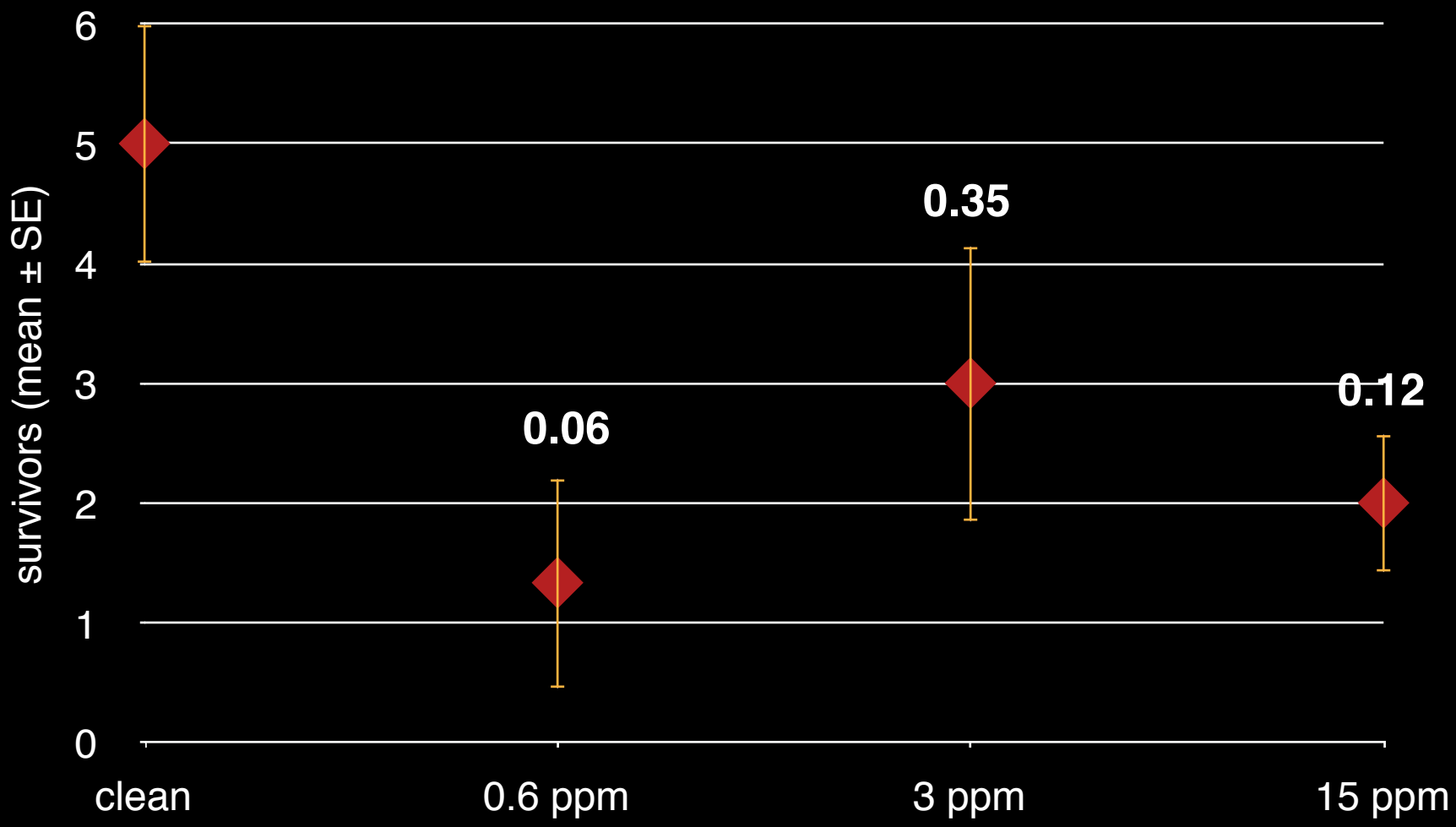



Stage E, ~30 dph


early juvenile, ~87 dph (42 days on sed)
2.7 cm


Stage G, ~42 dph (7 days on sed)
0.9 cm

Survival on Kitimat sediment at 47 days (2009)



ANOVA effect of treatment p = 0.1
Dunnett's post-hoc

Mortality 2011

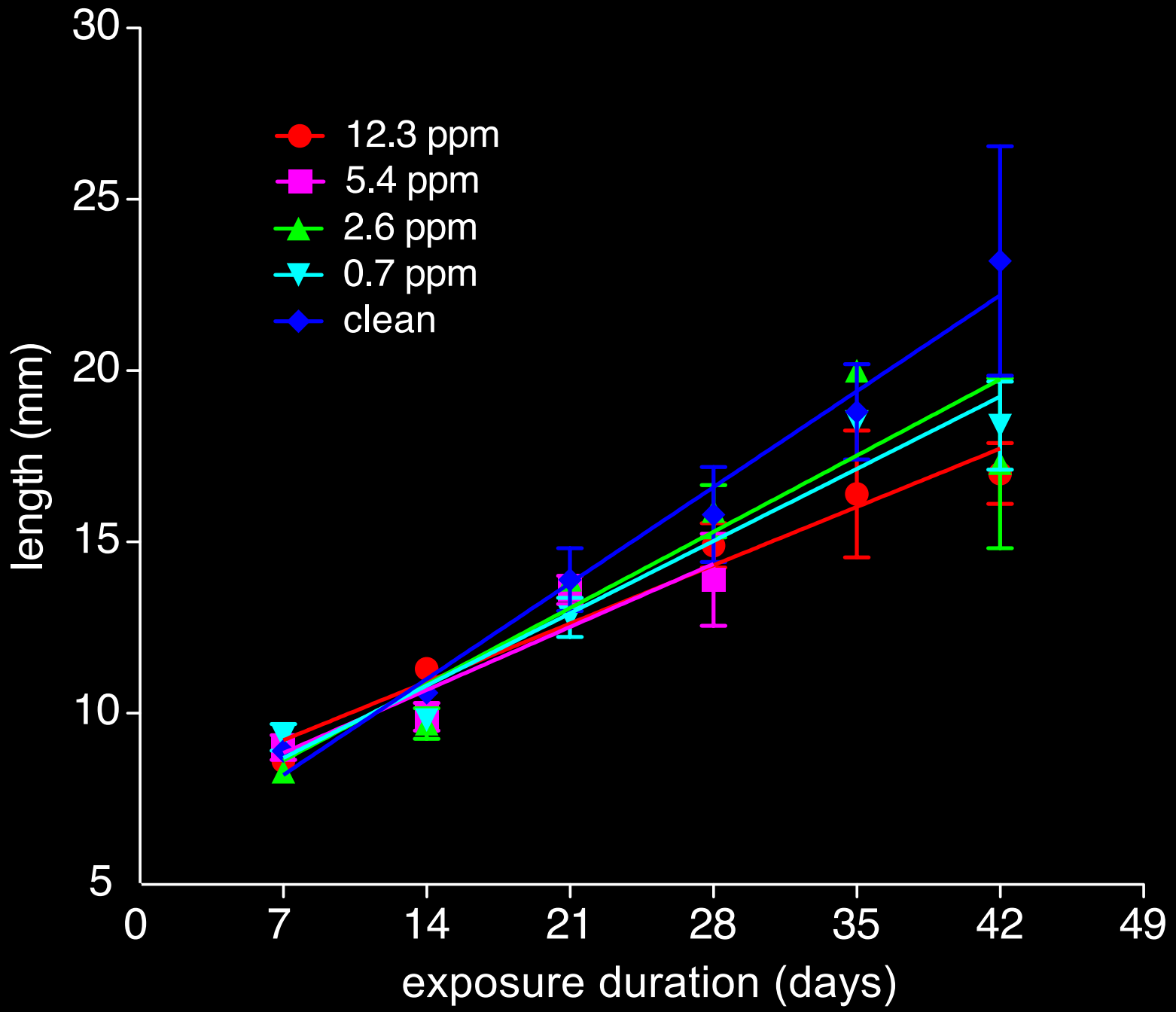
Table 3: Cumulative mortality among treatment groups

Treatment	Control	0.8 ppm	2.6 ppm	5.4 ppm	12.3 ppm
Mortality	56 ± 7	68 ± 13	73 ± 7	67 ± 13	64 ± 9

Table 1: Comparable metamorphosis on control and highest concentration of Kitimat sediment

Treatment	Time point	N	% Stage G	% Stage H	% Stage I	% Left-sided	% Right-sided
Control	day 7	9	56	7	0	25	75
	day 14	7		43	57	71	29
	day 21	10		40	60	60	40
	day 28	6		33	67	67	33
	day 35	5		60	40	40	60
	day 42	3		0	100	67	33
12.3 ppm	day 7	8	50	50	0	75	25
	day 14	4		75	25	50	50
	day 21	0					
	day 28	6		33	67	67	33
	day 35	7		57	43	57	43
	day 42	10		20	80	40	40

Growth on Kitimat sediment (2011)



Feeding

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- An enriched aquaculture diet optimized for maximal fish production

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- Phytoplankton-enriched rotifers

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- Phytoplankton-enriched rotifers
- Phytoplankton-enriched Artemia

Feeding

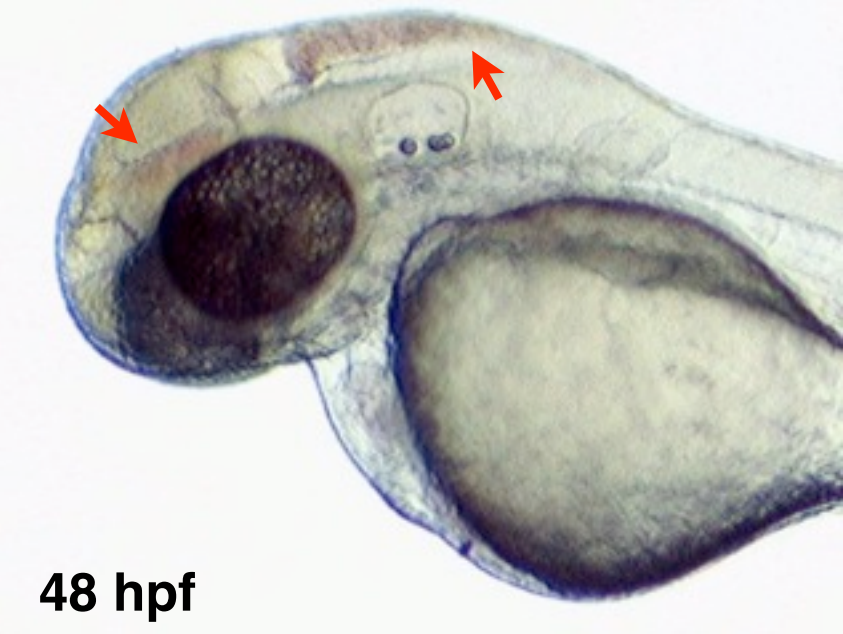
- An enriched aquaculture diet optimized for maximal fish production
- Phytoplankton-enriched rotifers
- Phytoplankton-enriched Artemia
- minced krill

Feeding

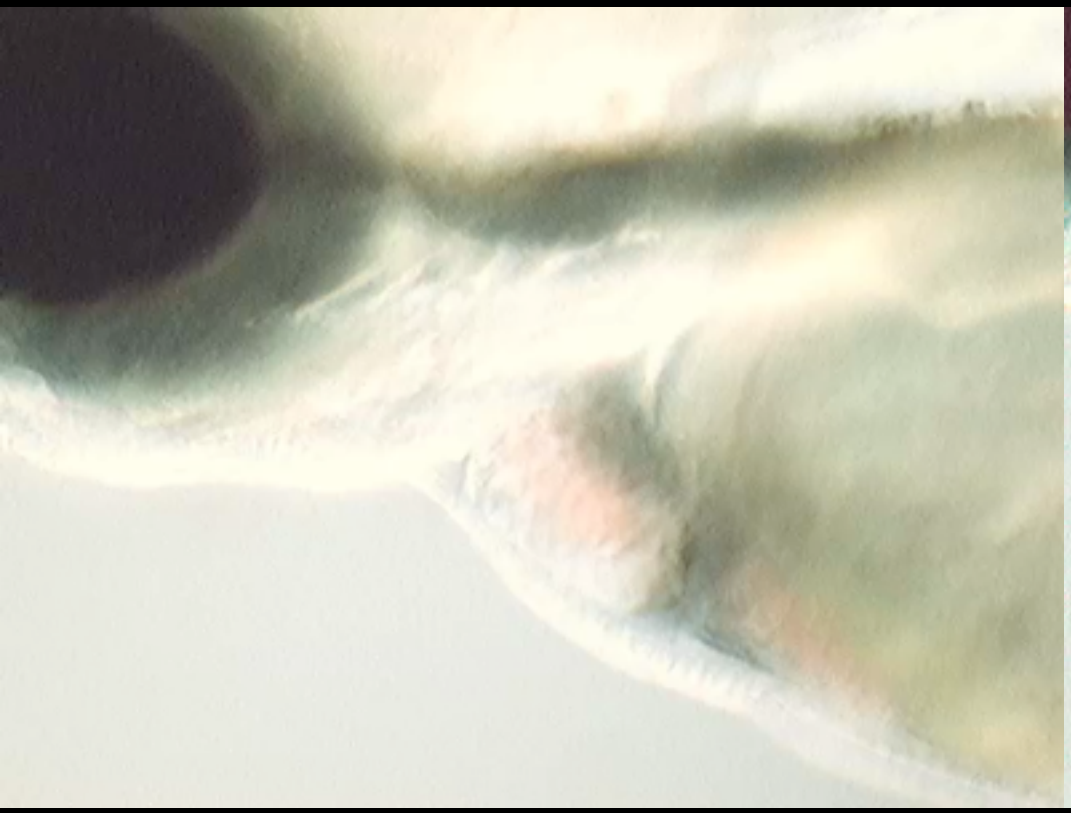
- An enriched aquaculture diet optimized for maximal fish production
- Phytoplankton-enriched rotifers
- Phytoplankton-enriched Artemia
- minced krill
- Hand fed little baby pigs

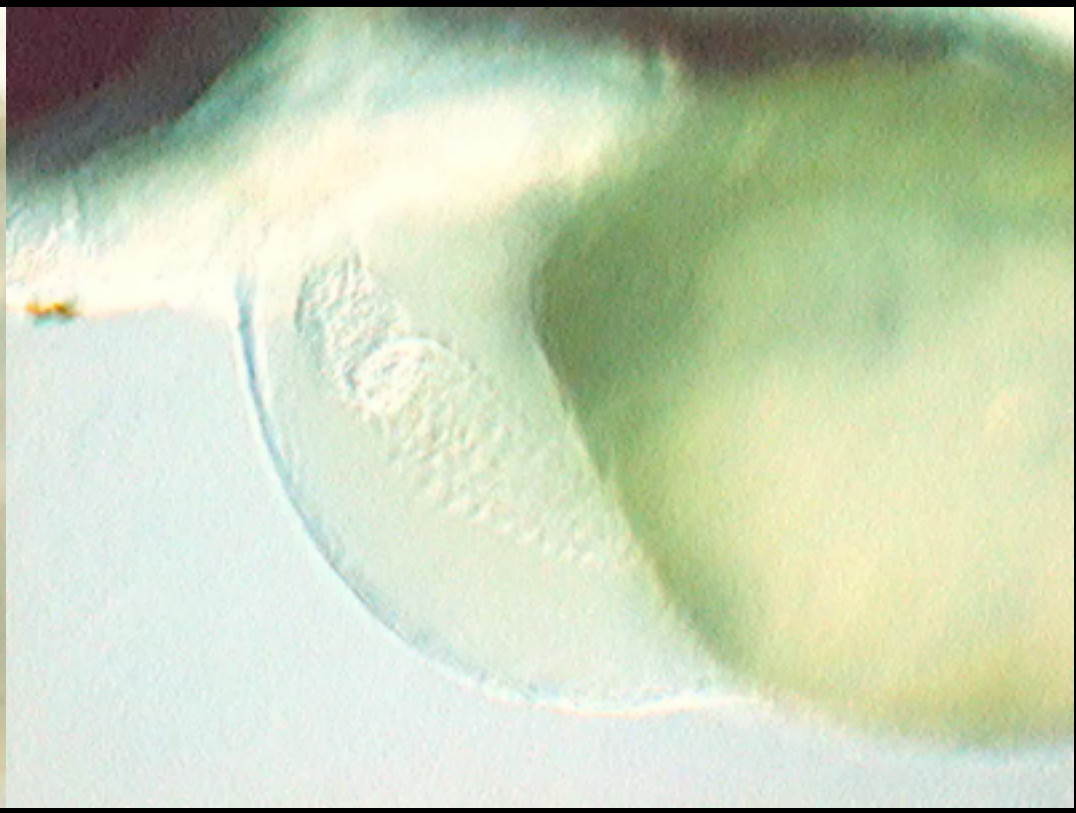
benzo[*a*]pyrene

72 hpf

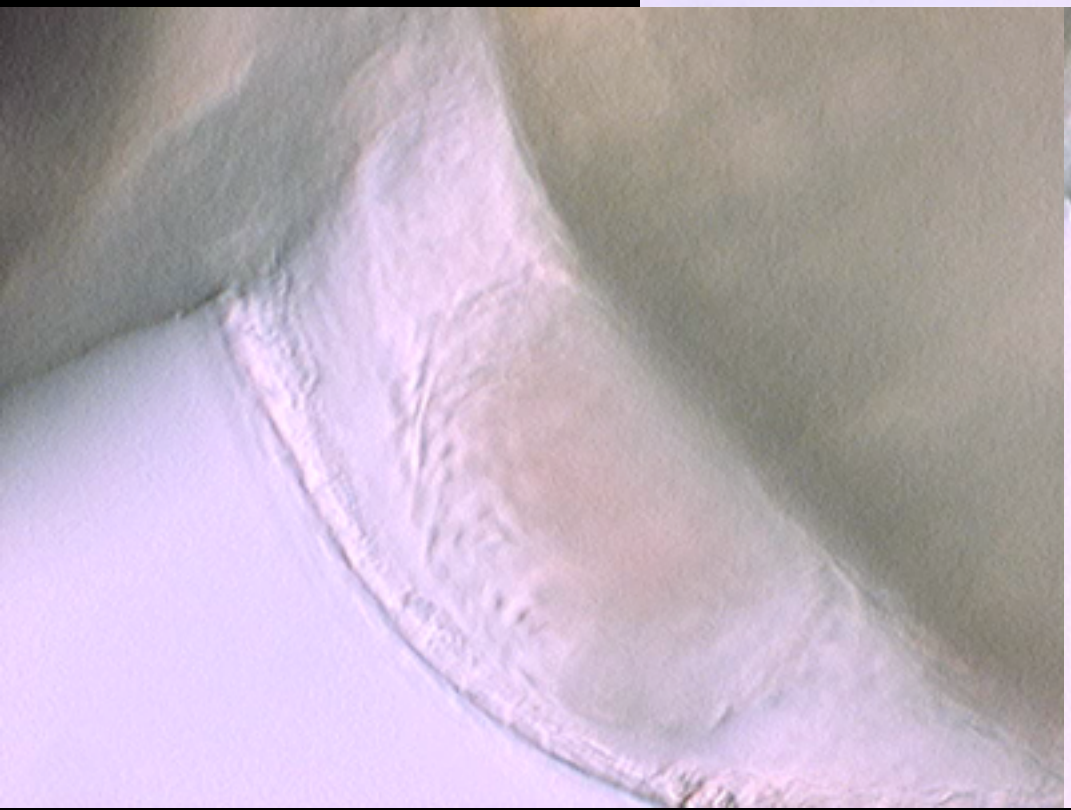


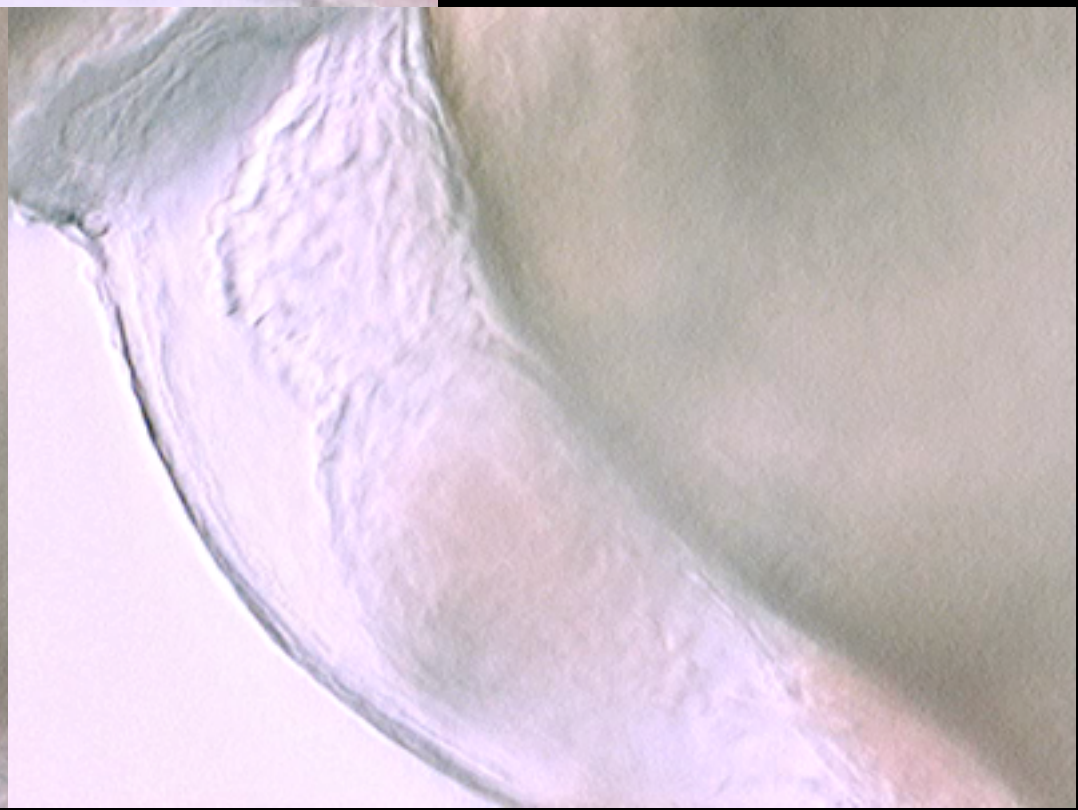
48 hpf

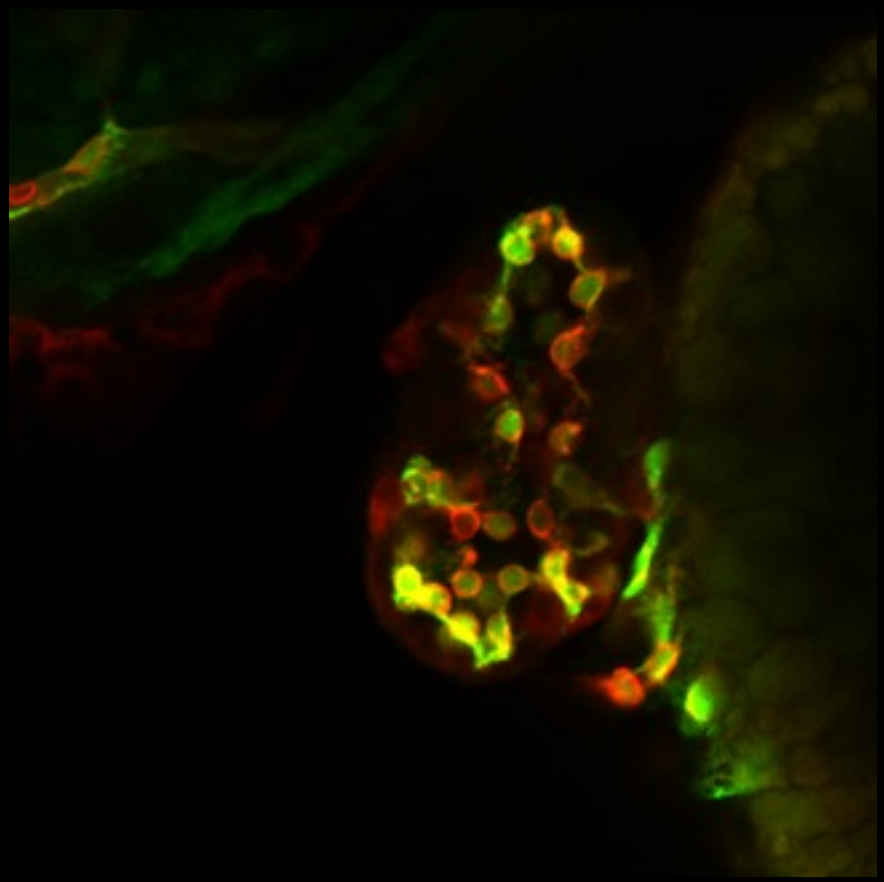


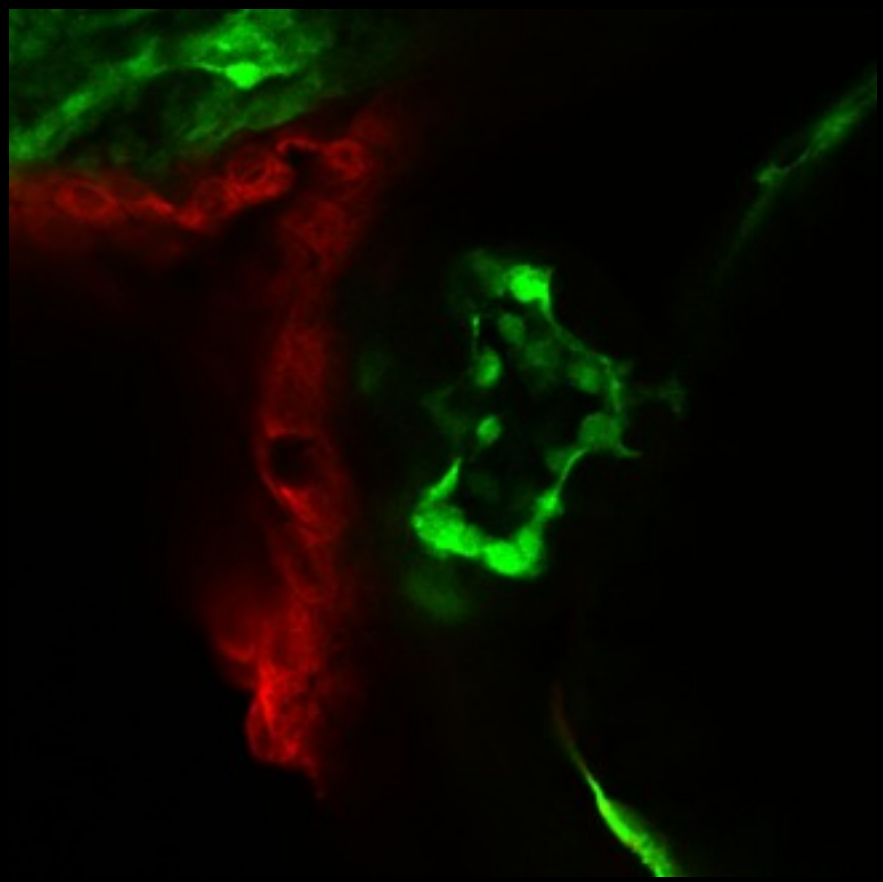


Distinct cardiac effects of BkF

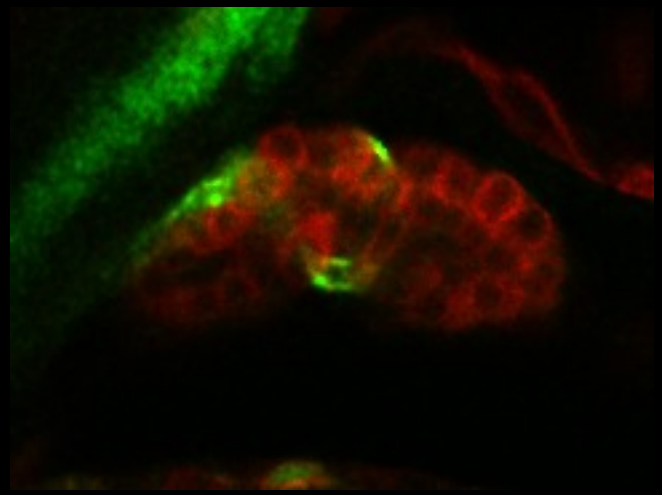








heart: endothelium (fli1GFP) CYP1A



liver bud