Aquatic Stressors and Pathology

Andrew S. Kane, Ph.D.
University of Florida
College of Public Health and Health Professions
Department of Environmental and Global Health

Aquatic Pathobiology Laboratory
Emerging Pathogens Institute
http://aquaticpath.phhp.ufl.edu
kane@ufl.edu

Objectives:

- Understand the multifactorial nature of various disease entities
- Give examples of different stress agents and disease-causing organisms
- Understand the relationship between stress factors and opportunistic pathogens
- Understand the continuum of biological responses to stress exposure and how these can be used in biomonitoring

Environmental Stressors

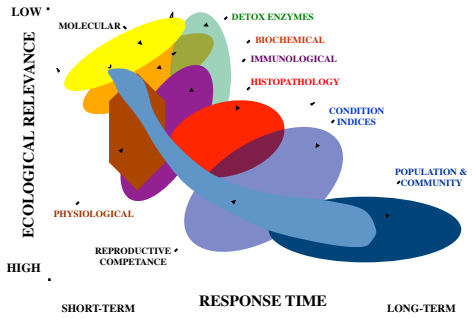
Stress

Physical: trauma
suboptimal habitat/irritants
thermal/irraditaion

Chemical: suboptimal water quality
contaminants /toxins

Biological: suboptimal food availability
pathogens/parasites
environmental unease

Continuum of Biological Responses



Stress = Predisposition

Algal blooms & hypoxia

Captive breeding

Captive breeding

Name that ulcer!

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Name that ulcer!

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Name that ulcer!

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Name that ulcer!

Name that ulcer!

Name that ulcer!

- *Edwardsiella tarda* (gram neg bacterium)

- Viral hemorrhagic septicemia virus

- Myxosporidean infection (protozoan parasite)

- Mycobacteria (gram positive bacterium)

- *Aeromonas salmonicida* (gram neg bacterium)

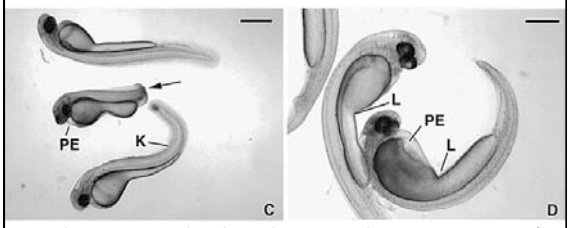
Gross pathology observations

Ascites and exopthalmia

Gross pathology observations

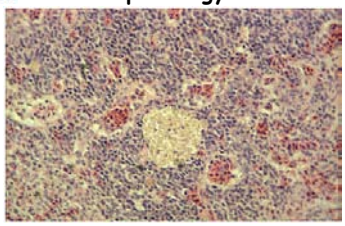
Ascites and exopthalmia

Stress Exposure Outcomes



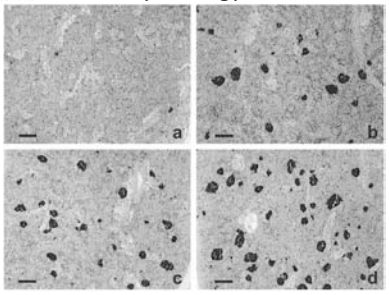
Larval Sacramento splittail one day post-48 hr exposure to 15 mg/L Se. Terratogenic effects include tail deformities (side-bend, kyphosis, lordosis) and pericardial edema. From The et al. 2002. Mar. Env. Res. 54:605-608.

Histopathology observations



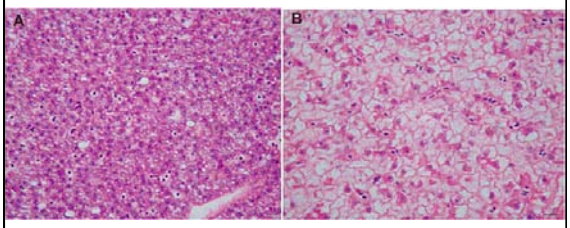
Macrophage aggregates are grouping of pigment-containing cells (macrophages & lymnphocytes) in different poikilothermic vertebrates. MAs mostly in spleen but also other organs. Capture & storage of cellular metabolites and antigen trapping; presentation to lymphocytes.

Histopathology observations



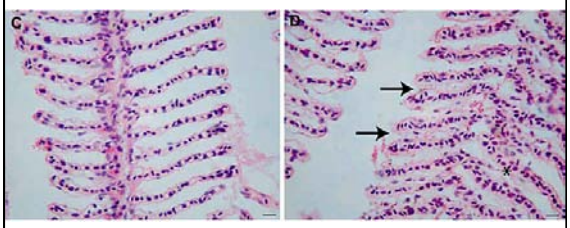
Histologic sections from Atlantic croaker spleens showing ranked categories of macrophage aggregate densities. From Fournie et al. 2001. J. Aquat Animal Health 13:105-116.

Histopathology observations



Control (A) and 70 ng TCDD/g zebrafish liver tissue. Exposed fish liver shows hepatocyte hypertrophy and lipidosis. From Zoderow et al. 2004. Aquat. Tox 66:25-38.

Histopathology observations



Control (A) and 70 ng TCDD/g zebrafish gill tissue. Exposed fish gills show epithelial hypertrophy and fusion of secondary lamellae. From Zoderow et al. 2004. Aquat. Tox 66:25-38.

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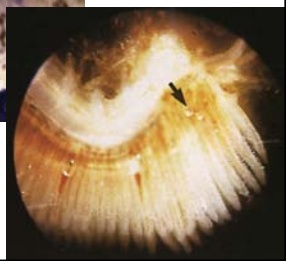
Gross pathology observations



Gas bubble disease

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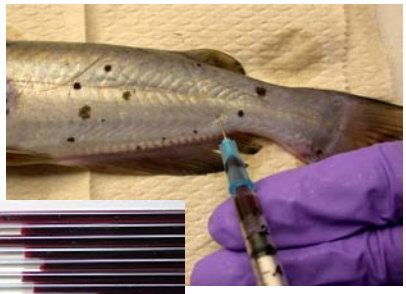
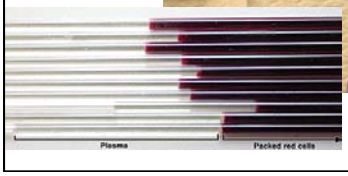
Gross pathology observations





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Gross pathology observations

Skin/mucus scrape

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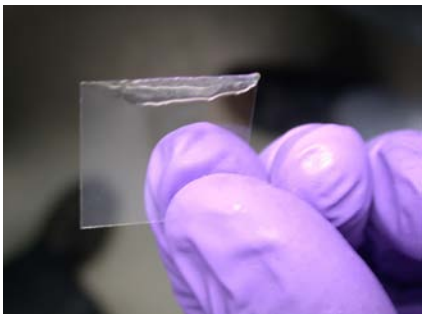
Gross pathology observations



Skin/mucus scrape

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Gross pathology observations

Gut scrape

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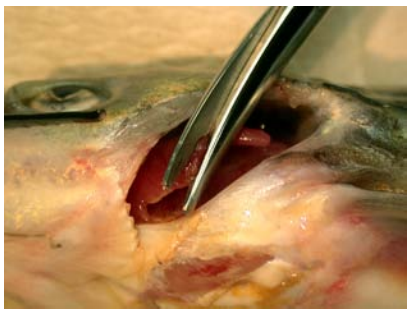
Gross pathology observations



Gill biopsy

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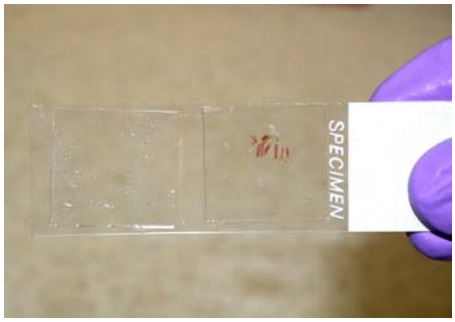
Gross pathology observations



Wet-mount observations

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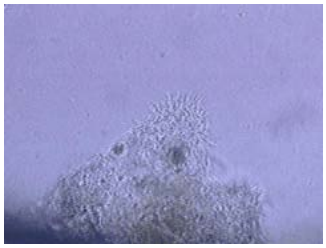
Gross pathology observations



Flavobacterium columnare
(Flexibacter columnaris)

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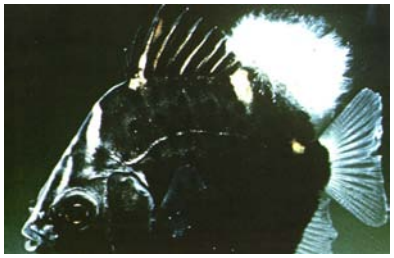
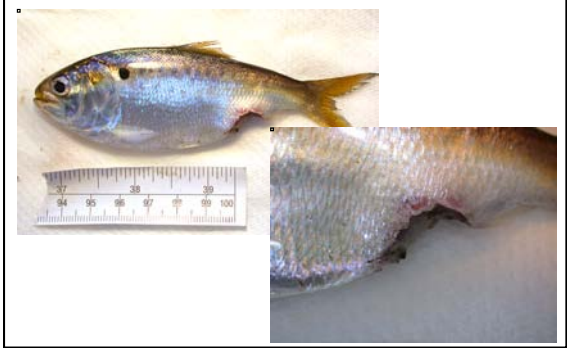
Gross pathology observations



"Cotton wool disease"
Saprolegnia, fungus

Gross pathology observations



Parasite observations

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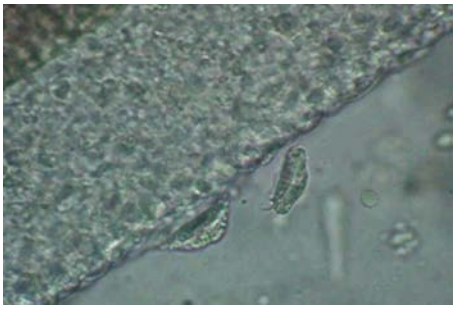
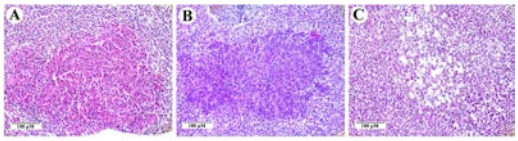


Parasite observations

PAH exposure

Altered foci



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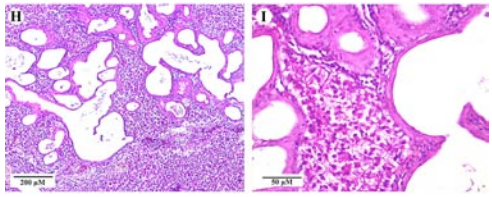
Cholangioma



Well-differentiated ductular structures

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Neoplasia

- Tumor literally means swelling.
- Primary etiology is environmental contamination, but cause and effect data weak. Some are associated with viruses.
- Moldy feed - aflatoxin.
- Many skin tumors are benign, but may grow very large.
- Most common are skin and liver alterations.

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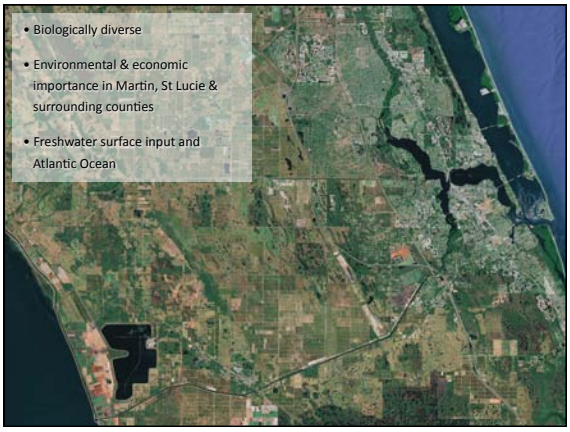
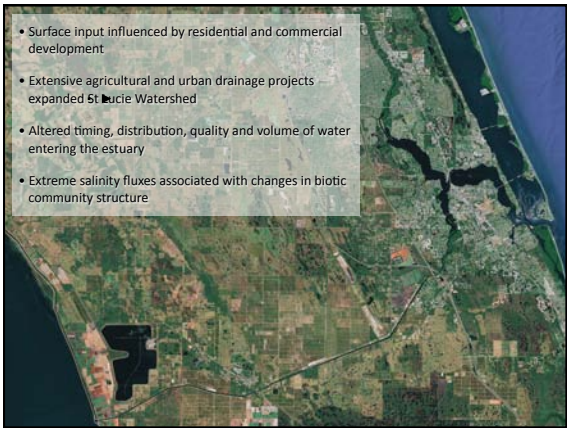
Fish Deformities and Stress In the St. Lucie Estuary System

Andrew S. Kane
Department of Environmental & Global Health
College of Public Health & Health Professions

David Reese
Department of Small Animal Clinical Sciences
College of Veterinary Medicine

Joan A. Browder
NOAA Southeast Fisheries Science Center





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34 Cases

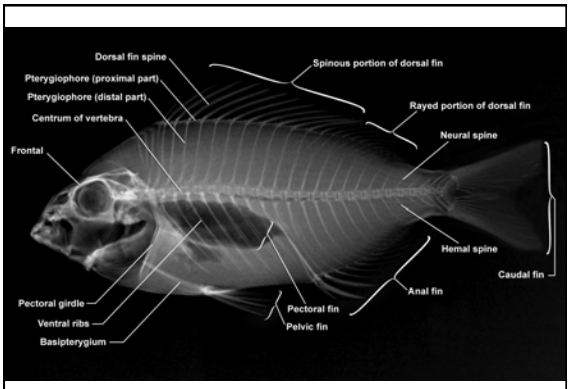
11 species representing 7 families

Common name	Scientific name	Family	# Specimens
Black margate	*Anisotremus surinamensis*	Haemulidae	8
Blue Runner	*Caranx crysos*	Carangidae	1
Dusky Damselfish	*Stegastes adustus*	Pomacentridae	1
French Angelfish	*Pomacanthus paru*	Pomacanthidae	2
Mangrove snapper	*Lutjanus griseus*	Lutjanidae	1
Pinfish	*Lagodon rhomboides*	Sparidae	8
Porkfish	*Anisotremus virginicus*	Haemulidae	4
Irish Pompano	*Diapterus auratus*	Gerreidae	1
Silver Porgy	*Diplodus argenteus caudimacula*	Sparidae	3
Sheepshead	*Archosargus probatocephalus*	Sparidae	1
White Margate	*Haemulon album*	Haemulidae	4

Observational data collection

- Gross photography

- Radiography
  - Kodak CR850 DICOM system
  - Measurements made using digital calipers



Case Observations

Case 59. Specimen is a pinfish, *Lagodon rhomboides*. TL = 248 mm. There is a 24 mm concave defect along the soft tissue of the dorsum. The 4th, 5th and 6th dorsal fin spines are absent; the base of the 4th dorsal fin spine remains, as observed radiographically, beneath the skin. The proximal elements of the 8th and 9th pterygiophores are absent. The proximal element of the 10th pteryigphore is misshapen and reduced in mineral opacity. The 9th and 10 distal pteryigophores are reduced in mineral opacity. The 8th, 9th and 10th distal pteryigophores are misaligned.

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Comparative observations

- Idiopathic
- Parasites:
  trematodes, nematodes, protozoans
- Trauma: net capture, UV, handling
- Infection / disease
  e.g., mycobacteria, fungi / tumors)
- Literature "suggestions": Contaminant exposure, diet, age, genetic

White Perch (Ches Bay)

UF UNIVERSITY of FLORIDA White perch (Ches Bay)

UF UNIVERSITY of FLORIDA Striped bass (Ches Bay)

UF UNIVERSITY of FLORIDA Killifish (Ches Bay)

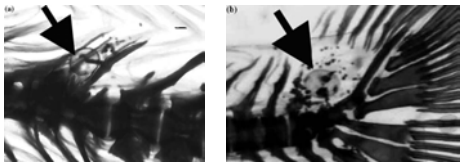
Parasites: nematode

Atlantic menhaden (Ches Bay)

Fungi-like: Oomycete (*Aphanomyces*)

Northern pikeminnow (Willamette R)

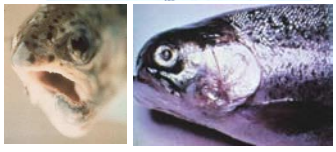
Parasites: digenetic trematode cysts



Cunningham et al. 2005 Env Biol Fishes 73:9-19

Whirling disease (trout)

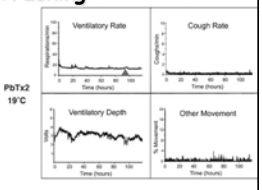
Parasites: myxozoan protozoans (*Myxobolus cerebralis*)

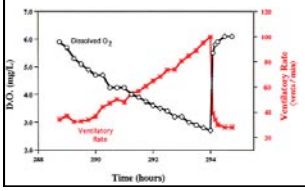


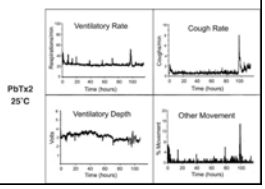
UF UNIVERSITY of FLORIDA FW Mullet (Turkey)

Jawad and Öktener 2007 Anales de Biologica 29:105-113

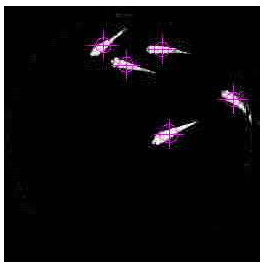
Behavioral Tracking







Behavioral Tracking



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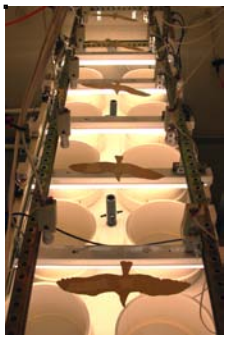

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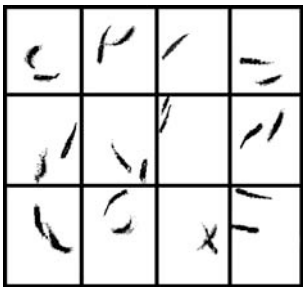
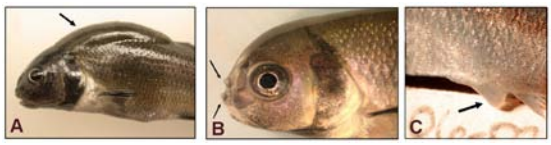
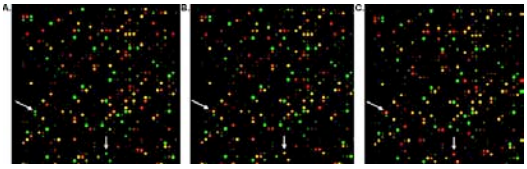


EE2 study: Gross observations



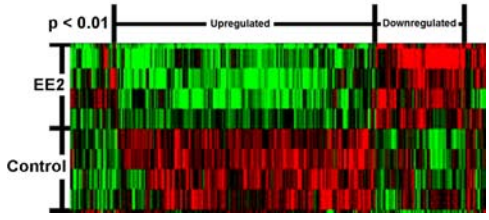
- Dorsal epithelial pad
- Tubercles (small, medium, large)
- Presence of ovipositor
- GSI; gonadal staging

Altered Gene Expression



Control 20 ng/L 100 ng/L

Altered Gene Expression



Fish Health References

AFS (American Fisheries Society) 1992. Investigation and Valuation of Fish Kills. American Fisheries Society Special Publication 24, Bethesda, Maryland.

ASTM (American Society for Testing and Materials) 1996. Standard Guide for Fish and Wildlife Incident Monitoring and Reporting. ASTM E1849-96.

Austin, B. and D.A. Austin. Bacterial Fish Pathogens. John Wiley and Sons, NY 1987.

Ferguson, H.W. *Systemic pathology of fish*. Iowa State University Press. Ames, Iowa, 1989.

Gratzek, J.B., ed. *Aquariology. The science of fish health management*. Tetra Press. Morris Plains, NJ, 1992.

Kane, A.S., *ed., FishGuts, A Multimedia Guide to the Art and Science of Fish Anatomy, Health and Necropsy* on CD-ROM for Mac/Win. APC Press, 1996. (http://aquaticpath.phhp.ufl.edu/fg).

Kane, A.S., A. Baya, R. Reimschuessel, K.M. St. Pe, C.A. Poukish and C.P. Driscoll. 1999. Field sampling and necropsy examination of fish. Virginia Journal of Science 50(4):345-364.

Kane, A.S. Online guide to fish lesion identification. http://aquaticpath.phhp.ufl.edu/lesionguide.html

Lom, J. and Dyková. 1992. Protozoan Parasites of Fishes. Developments in Aquaculture and Fisheries Science, 26. Elsevier Press.

Noga, E. 1999. Fish Disease: Diagnosis and Treatment. Iowa State University Press.

Reimschuessel, R., May, E.B., Bennett, R.O., Lipsky M.M. Necropsy examination of fish. *Veterinary Clinics of North America: Small Animal Practice*; 18:427-433, 1988.

Roberts, R.J. *ed., Fish Pathology*. 2nd. Ed. Bailliere Tindall. London, England, 1989.

Stoskopf, M. *Fish Medicine*. W.B. Saunders Company, Philadelphia, P.A., 1993.