Debris Detection and Observation Methods AT AHERC' S Tanana River Test Site (Nenana, Alaska)

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ACEP Alaska Center for Energy and Power

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The Alaska Hydrokinetic Energy Research Center (AHERC)

- Resides within ACEP which reports to the INE director
- Provide a statewide research, technology development, and information resource for marine and river hydrokinetic energy
- Focused on developing technology, methods, and information to facilitate the development of an environmentally compatible hydrokinetic power industry in Alaska
  - Baseline hydrodynamic studies (measurement & modeling)
  - Assess interactions between aquatic environment and hydrokinetic technology.
  - Develop supporting technology and methods (measurement, modeling, enabling)
  - Develop and disseminate data and information needed by stakeholders to make informed decisions.

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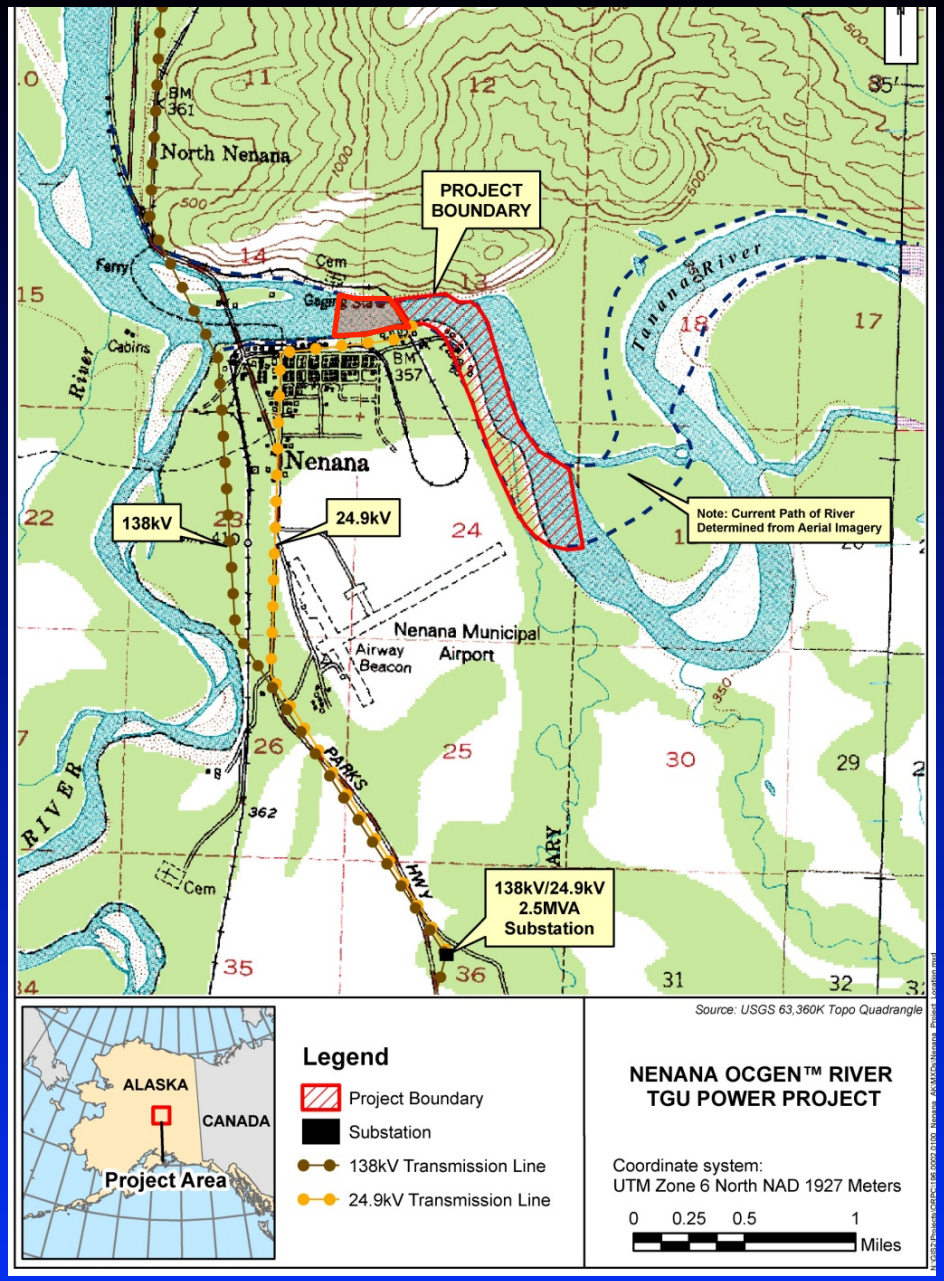
- **Tanana River Test Site** (Nenana, AK)
  - In collaboration with ORPC and the community of Nenana
- Goals: Assess interactions between the river environment and hydrokinetic technology
  - *River hydrodynamic measurements and modeling (power resource: summer & winter, sediment, turbulence)
  - *Fish populations and behavior
  - ^River debris (conditions & mitigation methods)
  - Turbine technology performance testing

***Baseline studies completed**
^ In-progress.



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Motivation

- Debris can severely impact the deployment, operation, and maintenance of hydrokinetic technology in river and tidal environments
  - Three hydrokinetic demonstration projects were ended because of both floating and submerged debris problems (two on the Yukon River and one on the Mackenzie river)
  - Over 80 rivers deposit debris into Cook Inlet, Alaska
  - Debris is now recognized as a major impediment to deploying and operating hydrokinetic devices in most Alaskan rivers and may affect some tidal regions
- To develop technology and methods to mitigate debris.

Yukon at Ruby

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Approach

- Use detection methods to provide data needed to develop technology and methods to mitigate debris effects on hydrokinetic technology including:
  - When and where debris occurs
  - What type, size, and volume of debris exists
  - What hazard does debris pose to devices (technology specific)
  - Determine most appropriate mitigation methods (site selection, diversion, detection/prediction & temporary diversion, move to safe position, or removal)
- Detection and observation methods:
  - Personal observation & photography
  - Video and Time-lapse photography
  - Mechanical debris detection device (MDDD)
  - Subsurface collection (e.g., nets/samplers)
  - High resolution sonar.

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Video Observation Of Debris

- Motion in the current
- Type identification
- Statistics (size, location, frequency)
- Interaction with devices

*Show video example of debris interaction with fishwheel

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Time-Lapse Photography Of Debris

Cameras

Battery & controller box

- Motion in the current
- Type identification
- Statistics (size, location, frequency)

- Show additional video example

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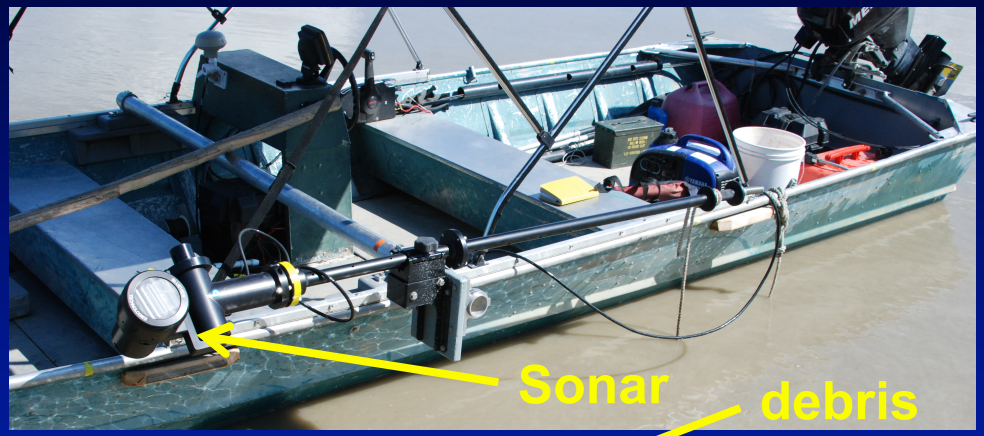
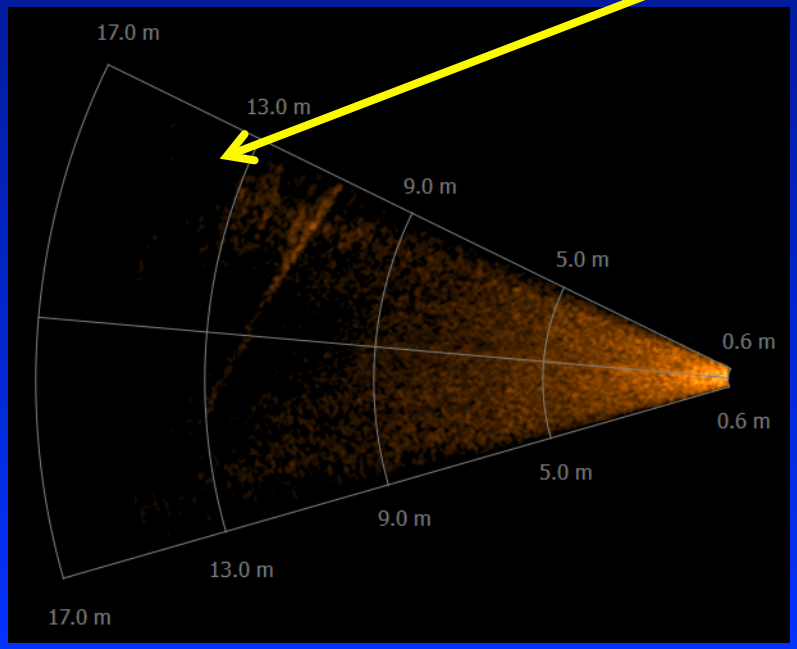
High-Resolution Sonar 900 kHz





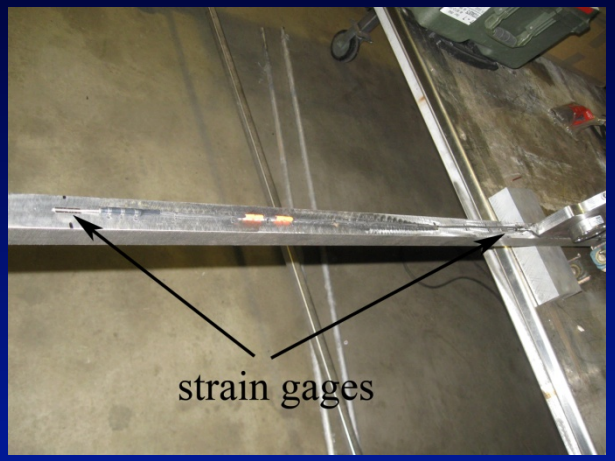
- Image subsurface debris
- Detect subsurface debris to initiate debris mitigation???
- Problems include:
  - Signal scatter from sediment
  - Detecting leafy debris and debris head-on
  - Detecting debris with sufficient time for action

Physical Sampling of Small-Scale Debris

- Small-scale debris in the lower third of the river (bark, twigs)
  - Confuses sonar interpretation of bathymetry and bed load sediment transport
  - May impact hydrokinetic device performance

Self-Clearing MDDD

Mechanical debris detection device (MDDD)



- Detect & characterize subsurface debris
- Estimate impact loads
- Initiate debris mitigation???

Notched cam following spring assembly

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Debris origins

- Primary: River bank erosion in forest regions
  - Increases with river stage

- Secondary: entrainment of stranded debris
  - Increases with river stage

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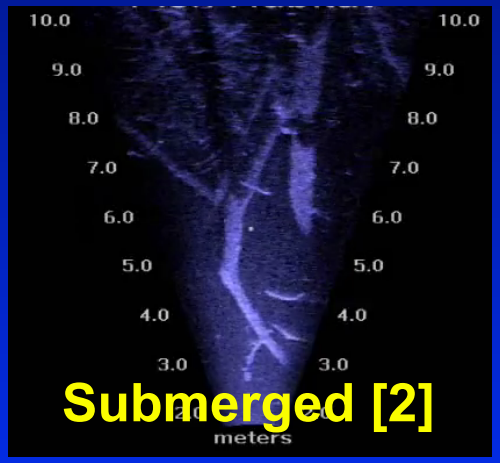
Debris Extent

- Debris exists throughout the water column over a wide size scale.

Small scale submerged



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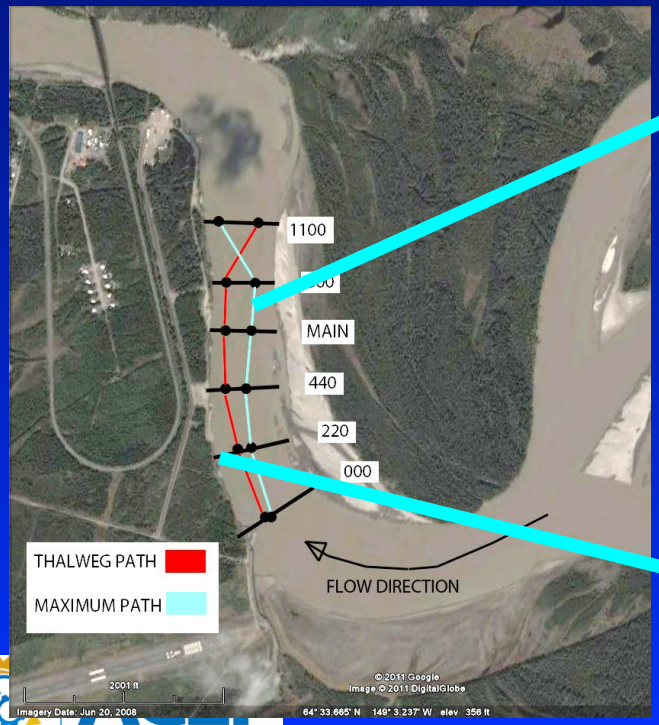
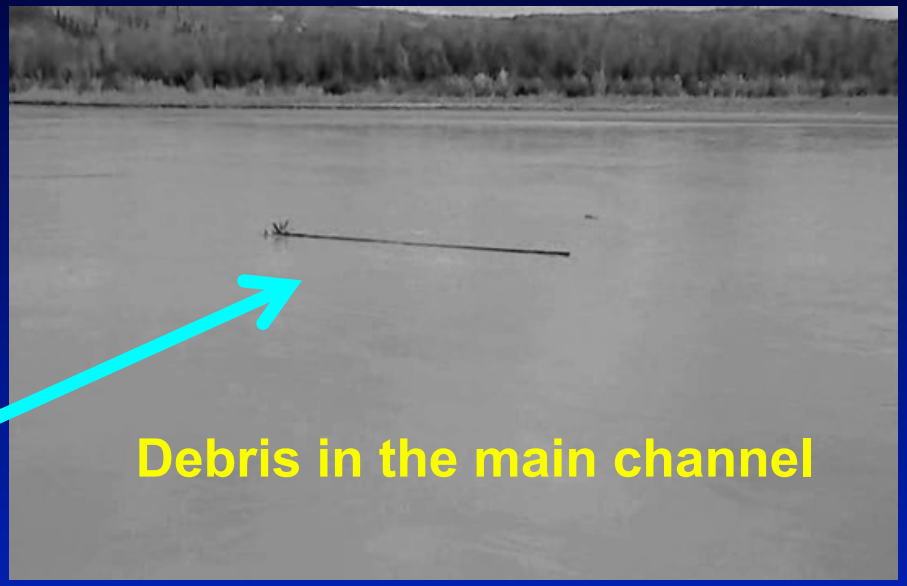
Debris Location

- Debris generally follows the path of maximum current or power
- Turbulence and debris inertia can move debris out of the main channel





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AHERC Debris Diversion Test Buoy And Platform

- Test hydrodynamic (buoy wake) and mechanical (platform) diversion methods
  - Determine probability of impact
  - Effectiveness of diversion
  - Drag forces and debris loading

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Conclusions

- Debris is a major impediment to sustainable operations of hydrokinetic devices in Alaskan rivers (and possibly Cook Inlet tidal regions)
- A variety of debris detection methods are needed to characterize surface & subsurface debris to determine possible effects on hydrokinetic devices and to develop mitigation methods and technologies
  - Camera, video, sonar, physical subsurface sampling, and Mechanical detection devices
  - Deployed structures

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