Biological Modeling Outline

1. **Model**
    a. **Response**
    b. **NRD**
2. **Data inputs for model**
    a. **Empirical data from spill response**
    b. **Data from literature**
3. **Inputs from other models**
4. **Outputs**

II. Birds, mammals, reptiles

1. **Model -Glenn**
    a. **Response**
    b. **NRD**
2. **Data inputs for model**
    a. **Empirical data from spill response (Glenn)**
    b. **Data from literature (Rebecca, Peter)**
3. **Inputs from other models (Debbie)**
4. **Outputs (Debbie)**

b. Exposure evaluation
    i. Oil components
        1. floating oil (including all weathering states)
        2. entrained droplets (including adsorbed to suspended sediments)
        3. dissolved hydrocarbons
        4. oil in sediments (subtidal)
        5. oil on shoreline and other habitats
    ii. Consideration of behavior, life history
        1. Vulnerability
        2. Normal, avoidance and attraction.
        3. Scavenging
        4. Post oiling behavior
    iii. Via food chain
c. Effects on individuals (Peter and Rebecca)
    i. Of exposure (thermal and mechanical)

    ii. Toxicity
        1. Acute effects (lethal, sublethal) of short-term exposures (considering duration of exposure from <12 hrs to weeks)
        2. Long-term effects of short-term and long-term exposures on development, growth, reproduction, etc.
        3. Chronic effects
d. Population level impacts

i. Recovery rate , interim loss
ii. Restoration: REA

III. Fish and Invertebrates

1. Model (Debbie)
a. Response
b. NRD
2. Data inputs for model
a. Empirical data from spill response (Kate)
b. Data from literature
i. Life history (Kate)
ii. Effects (Amy, Jim)
3. Inputs from other models (Debbie)
4. Outputs (Debbie)

b. Exposure evaluation
i. to floating oil, entrained droplets, dissolved hydrocarbons, oil in sediments, oil on shoreline
ii. Consideration of behavior , life history
1. Vulnerability
2. Normal, avoidance and attraction
3. Scavenging
4. Post oiling behavior
iii. Via food chain
c. Effects on Individuals
i. Bioconcentration/accumulation of hydrocarbons in tissues
1. Pathways (water, gill, gut, etc.)
2. Rates of uptake and depuration
3. Metabolism
ii. Toxicity
1. Acute effects (lethal, sublethal) of short-term exposures (considering duration of exposure from <12 hrs to weeks)
2. Long-term effects of short-term exposures on development, growth, reproduction, etc.
3. Chronic effects
4. Phototoxicity of PAHs
iii. Mechanical/smothering effects of (whole) oil on aquatic biota
iv. Disease
d. Population level effects
i. Recovery, interim loss
ii. Restoration
1. REA (Resource Equivalency Analysis)
2. HEA (Habitat Equivalency Analysis)

IV. Habitats (Marshes, Mangroves, Invertebrate reefs)

1. **Model (Debbie)**
    a. **Response**
    b. **NRD**
2. **Data inputs for model**
    a. **Map of habitat types and bathymetry (Debbie)**
    b. **Empirical data from spill response (Rob)**
    c. **Data from literature**
        i. **Characterization (structural, functional) of habitats (Kate)**
            1. **Wetlands, coral, etc (**
        ii. **Effects (Kate)**
            1. **Plants**
            2. **Invertebrates**
3. **Inputs from other models (Debbie)**
    a. **Shoreline oiling: area and duration**
    b. **Waterborne exposure**
4. **Outputs (Debbie)**

b. Exposure
    i. Via stranding
        1. Intertidal zone
        2. Terrestrial during storm surge
    ii. Aquatic (Subtidal and submerged freshwater)
        1. Entrainment – whole oil droplets
        2. Dissolved components
        3. Deposition
c. Effects
    i. Adverse effects levels of petroleum
        1. whole oil and droplets – Mechanical/smothering effects
        2. dissolved
            a. uptake
            b. toxicity
    ii. Lost production (plants, invertebrates, dependant species)
    iii. Loss of structure
        1. Effects on biota using habitat for foraging, reproduction, nursery (consider habitat value and suitability)
        2. Erosion issues (ecosystem level effects)
    iv. Enhancement (hormesis)
    v. Of response activities
d. Recovery – modeling interim loss
    i. Oil contaminated
    ii. Impacted by response

e. Restoration – HEA (Habitat Equivalency Analysis; in-kind vs out of kind)

V. Inputs from Other Models
   a. floating oil
   b. entrained droplets
   c. dissolved hydrocarbons
   d. oil in sediments
   e. oil on shoreline and other habitats

VI. Outputs
   a. Birds
   b. Mammals
   c. Reptiles
   d. Fish and Invertebrats
   e. Habitats

Inputs from other models

Mapping
- -Shoreline and habitats
- -Bathymetry
- -Resolution

Transport information
- -Currents
- -Waves
- -Turbulent mixing
- -Water level

Oil distribution in space and time
- -Floating oil (including all weathering states: slicks, mousse, tar balls)
- -Entrained droplets (including adsorbed to suspended sediments)
- -Dissolved hydrocarbon concentrations (by pseudo-components)
- -Oil in sediments (subtidal)
- -Oil on shoreline habitats

Outputs
- -Numbers of animals oiled by species or group
- -Areas affected by habitat
- -Volumes of water where there is potential for toxicity

Exclusions

- -Only marine, estuarine (not inland areas)
- -Non-petroleum spills
- -Human exposure/losses
- -Food web