CHALLENGES, IMPACTS AND OUTCOMES FROM EACH RESEARCH TEAMS

1. BIRD TEAM

Challenges

- **Survey & Estimate**:
  - Require day and night surveys for nocturnal and non-nocturnal bird
  - Estimation of bird population of each species.

- **Habitat pressures**:
  - Intrusion into Bukit Juru Forest Reserve by the public.
  - Spread of non-native plant species competing with native flora that provide food for birds.
  - Abandoned rice fields not managed for conservation, reducing roosting areas for shorebirds.

- **Knowledge gaps**:
  - Lack of long-term studies on how migratory birds interact with resident species.
  - Need for more research on flyway corridors between Penang Island and Seberang Perai Tengah, especially under climate change.

Impact

- **Biodiversity richness**:
  - 168 bird species recorded.
  - 17 species recorded for the first time in Juru.
  - 45 migratory species supplementing 122 resident species.

- **Conservation significance**:
  - 5 globally threatened/near-threatened species documented (e.g., Black-capped Kingfisher, Eurasian Curlew, Curlew Sandpiper, Lesser Adjutant, Mangrove Pitta).
  - Breeding activity confirmed for multiple resident species, showing the area's role as a viable habitat.

- **Ecological role of habitats**:
  - Mangroves, mudflats, rice fields, and forest reserves provide roosting, feeding, and breeding grounds.
  - Evidence of large-scale bird movement (e.g., 400+ bee-eaters observed migrating across Bukit Juru).

Outcomes

- **Checklist creation**: A comprehensive avifauna checklist for Greater Juru, combining historical and new records.

- **Conservation recommendations**:
  - Strengthen monitoring of Bukit Juru Forest Reserve.
  - Designate abandoned rice fields as conservation areas for shorebirds.
  - Establish a visitor information centre to support eco-tourism.

- **Eco-tourism potential**: The diversity of birds and existing infrastructure position Greater Juru as a promising nature tourism destination.

- **Awareness raised**: The survey highlights the importance of protecting habitats and managing human activity to sustain bird populations.

2. FISH AND WATER QUALITY TEAM

Challenges

- **Severe pollution**:
  - Sungai Juru classified between **Class III–IV** under Malaysia's National Water Quality Standards.
  - High loads of **ammonia (2.1–5.6 mg/L)** and **phosphate (up to 12 mg/L)** from sewage and agriculture.
  - **Low dissolved oxygen (2.2–3.7 mg/L)**, insufficient to support healthy aquatic life.
- **Aquaculture and drainage inputs**:
  - Two major drains and aquaculture farms contribute pollutants.
  - Low-tide conditions showed foul odour, murky water, and poor freshwater quality.
- **Biodiversity decline**:
  - Only **18 species of fish and shellfish** recorded, with **3 shellfish species** (9 individuals).
  - Sampling showed low diversity indices (Shannon average ≈ 0.97), indicating poor species richness and uneven distribution.
- **Sampling limitations**:
  - Net placement and mesh size restricted catch efficiency.
  - Rainfall events disrupted sampling, skewing species counts.

Impact

- **Ecological stress**:
  - Excess nutrients (ammonia, phosphate) drive oxygen depletion, limiting biogenic processes.
  - Microbial imbalance: oxygen-scavenging microbes dominate, reducing natural recovery capacity.
- **Aquatic life**:
  - Fish populations fragmented; species segregate into certain river sections rather than evenly distributed.
  - Shellfish presence minimal, suggesting habitat degradation.
- **Human and environmental risk**:
  - Water unsuitable for drinking due to ammonia and phosphate exceeding safety thresholds.
  - Potential long-term bioaccumulation of heavy metals in fish tissue (cadmium, lead noted in earlier studies).

Outcomes

- **Findings confirmed**: Sungai Juru remains heavily impacted by sewage and nutrient pollution, with biodiversity far below healthy river standards.
- **Recommendations proposed**:
  - **No dredging** to avoid further circulation of solids.
  - Strengthen sewage treatment monitoring with **Indah Water Consortium** to identify leaks and prioritize servicing.
  - Leverage natural wetlands and mangrove vegetation as **biofilters** to aid recovery.
- **Conservation insight**: Despite degradation, the river still shows signs of biogenic processes and natural filtering, meaning recovery is possible with proper intervention.

3. FLORA TEAM

3.1 TERRESTRIAL FLORA (BUKIT JURU PERMANENT FOREST RESERVE)

Challenges

- **Habitat disturbance**:
  - Soil erosion along trails due to trampling and clearing.
  - Recreational activities (unregulated hiking, widening trails, creation of shortcuts) fragment habitats.
- **Introduction of non-native plants**: Ornamental species planted along trails risk becoming invasive.
- **Secondary forest degradation**: Past fires and clearing have reduced canopy cover, exposing less fertile soil.
- **Limited survey coverage**: Southwestern forest near quarry not explored due to accessibility issues.

Impacts

- **Biodiversity stress**: Native species like orchids (*Arachnis flos-aeris*) and shrubs (*Euphorbia ridleyi*) found only in small, isolated populations.
- **Habitat fragmentation**: Reduced resilience of native flora, especially in disturbed zones.
- **Cultural/ecological value**: Many species (e.g., *Curculigo latifolia*, *Melastoma malabathricum*) have medicinal or interpretive significance, but their populations are vulnerable to disturbance.

Outcomes

- **Recommendations**:
  - Replanting native species (seed collection from healthy dipterocarp forest, ex-situ nurseries).
  - Removal of non-native plants and replacement with native flora.
  - Workshops with local communities on sustainable trail use.
  - Strict regulation against new trail creation.
- **Conservation potential**: With community engagement and replanting, disturbed areas can be rehabilitated to restore biodiversity.

3.2 MANGROVE FLORA (SUNGAI JURU CATCHMENT)

Challenges

- **Industrial and urban disturbance**:
  - Factory zones and housing areas have replaced mangrove stands with non-native trees (e.g., *Acacia auriculiformis*).
  - Logging and land reclamation in coastal zones.
- **Habitat fragmentation**: Some stretches show sparse mangrove cover, while others are dominated by single species (e.g., pure stands of *Avicennia alba*).
- **Accessibility limits**: Upper reaches blocked by bridges, restricting survey coverage.

Impacts

- **Species distribution imbalance**:
  - Rich diversity in middle river zones (e.g., *Sonneratia caseolaris*, *Rhizophora apiculata*, *Xylocarpus granatum*), but monocultures dominate estuary and mudflats.
- **Loss of ecological services**: Reduced canopy and fragmented mangrove buffers weaken shoreline protection and nursery habitats for aquatic life.
- **Cultural/economic uses**: Many mangrove species provide timber, charcoal, tannins, and traditional medicine, but overuse and disturbance threaten sustainability.

Outcomes

- **Findings**:
  - At least 14 true mangrove species and 6 associates documented, showing high potential biodiversity.
  - Coastal zones like Kampung Sungai Semilang still host diverse, fruiting mangrove stands.
- **Recommendations**:
  - Protect gazetted Permanent Reserved Forest areas.
  - Remove invasive non-mangrove species in disturbed zones.
  - Strengthen monitoring of industrial encroachment.
  - Promote community awareness of mangrove value for fisheries, shoreline stability, and eco-tourism.

4. INSECT TEAM

Challenges

- **Pollution and urbanization**:
  - Water quality degradation and habitat loss along Sungai Juru reduce insect diversity.
  - Sensitive species like fireflies (*Pteroptyx valida*) are critically affected.
- **Habitat disturbance**:
  - Recreational and agricultural activities alter natural habitats, introducing risks of fragmentation.
  - Some sampling sites (e.g., Jetty areas) showed low captures due to heavy rain, highlighting vulnerability to climate variability.
- **Agricultural conflict**:
  - While butterflies enhance pollination, their larvae feed on crops (lime, crucifers, ornamental plants), creating tension between conservation and farming.

Impacts

- **Biodiversity richness**:
  - A total of **100 insect species** recorded across habitats (Nypa forest, riverbanks, AutoCity landscape, plots, jetties).
  - Butterflies were the most abundant group, contributing to pollination and ecosystem health.
- **Conservation concern**:
  - Fireflies (*Pteroptyx valida*) listed as **Vulnerable (IUCN)**, with critically low populations due to pollution and habitat loss.
  - Most other species were classified as **Least Concern**, showing resilience in disturbed habitats.
- **Ecosystem services**:
  - Insects play roles in pollination, nutrient cycling, pest regulation, and as food sources for other fauna.
  - Their diversity reflects the overall health of Sungai Juru's ecosystems.

Outcomes

- **Key findings**:
  - Highest insect diversity recorded in **landscape areas and Plot A**, showing that semi-natural and managed habitats can support rich insect communities.
  - Fireflies still present at Jetty 1 & 2, suggesting potential breeding grounds nearby.
- **Recommendations**:
  - Restore and protect habitats, especially mangroves and riparian zones, to support sensitive species like fireflies.
  - Balance conservation with agriculture by managing butterfly populations to reduce crop damage while maintaining pollination benefits.
  - Engage in proactive monitoring and habitat restoration to sustain insect diversity.
- **Conservation potential**:
  - Despite pollution, Sungai Juru still supports diverse insect life, indicating recovery is possible with targeted interventions.

5. REPTILES & AMPHIBIANS

Challenges

- **Scientific blind spot**: Prior to this survey, Sungai Juru had no comprehensive documentation of amphibians and reptiles, leaving a major knowledge gap.
- **Habitat degradation**: Industrialization, housing, and settlement development along the river have led to pollution, forest loss, and fragmentation of wetlands.
- **Species vulnerability**: Amphibians and reptiles are highly sensitive to habitat destruction, pollution, and climate change due to limited dispersal abilities.
- **Local threats**: Road mortality, harvesting for traditional medicine, and introduction of non-native species further stress populations.

Impacts

- **Biodiversity richness**: 132 individuals representing **23 species** recorded (9 amphibians, 14 reptiles).
- **Endangered species present**: Malayan Box Turtle (*Cuora amboinensis*) and Black Marsh Turtle (*Siebenrockiella crassicollis*) highlight urgent conservation needs.
- **Ecological roles**: Amphibians and reptiles act as predators of insects and prey for higher vertebrates, contributing to nutrient cycling and ecosystem balance.
- **Indicator species**: Their presence and distribution reflect the health of wetlands and highlight pollution and habitat stress.
- **Potential diversity**: Rarefaction analysis suggests more species remain undocumented, indicating Sungai Juru harbors higher herpetofauna diversity than currently recorded.

Outcomes

- **Baseline inventory established**: First comprehensive checklist of amphibians and reptiles in Sungai Juru, serving as a foundation for future conservation.
- **Conservation significance**: The wetlands are confirmed as ecologically important corridors supporting diverse herpetofauna.
- **Recommendations**:
  - Continued surveys to capture rare/cryptic species.
  - Habitat protection and rehabilitation of mangroves, swamps, and riparian zones.
  - Awareness programs to highlight ecological importance of amphibians and reptiles.
  - Integration of findings into ecotourism and ecosystem management strategies.
- **Long-term potential**: With proper protection, Sungai Juru can serve as a model site for biodiversity conservation and sustainable ecotourism in Penang.

6. MAMMAL TEAM

Challenges

- **Habitat disturbance**:
  - Quarry operations at Juru Hill cause noise, dust, and roadkill risks.
  - Recreational activities (open burning, planting non-native trees, widening trails) threaten native habitats.
- **Domestic animals**: Cats and dogs prey on wildlife and transmit diseases.
- **Secondary forest degradation**: Eastern and southern slopes dominated by secondary growth, reducing habitat quality.

Impacts

- **Species diversity**: 14 mammal species recorded, including endangered (Silvered Langur), vulnerable (Sunda Slow Loris, Smooth-coated Otter), and near-threatened species (Dusky Langur, Black Giant Squirrel).
- **Conservation concern**: Rare species like the Slow Loris are declining; Silvered Langur sightings highlight urgent need for protection.
- **Human-wildlife conflict**: Domestic animals and wild boar cause ecological imbalance and crop damage.
- **Habitat value**: Despite disturbances, Juru Hill's primary forest and mangroves still support diverse mammals, showing ecological significance.

Outcomes

- **Key findings**: Documentation of endangered and vulnerable species confirms Juru as an important conservation area.
- **Recommendations**:
  - Tree planting (fruit trees, dipterocarps) to enrich habitats.
  - Provide artificial water sources to support wildlife.
  - Regular surveys and monitoring to track mammal populations.
  - Stronger law enforcement against poaching and quarry encroachment.
  - Community awareness programs to reduce harmful recreational practices.
- **Conservation potential**: With habitat restoration and protection, Juru can remain a vital refuge for Penang's mammal diversity.