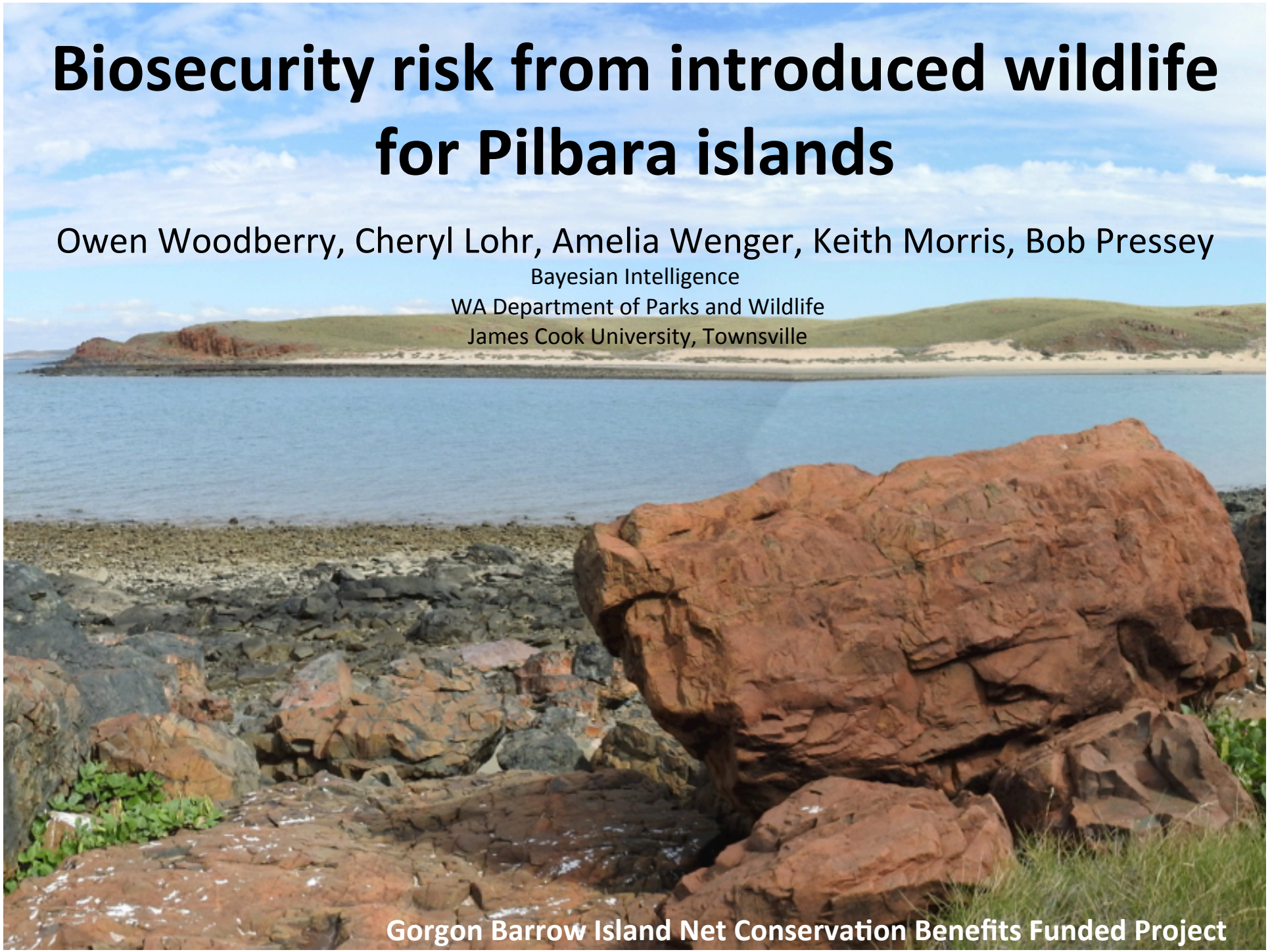
Biosecurity risk from introduced wildlife for Pilbara islands

Owen Woodberry, Cheryl Lohr, Amelia Wenger, Keith Morris, Bob Pressey

Bayesian Intelligence

WA Department of Parks and Wildlife

James Cook University, Townsville



Gorgon Barrow Island Net Conservation Benefits Funded Project

Biosecurity Risk (Common Projects)

Western Australia Islands (Pilbara) (WAB)

- James Cook University & WA Department of Parks and Wildlife

Northern Australia Islands (Torres Straight) (NAB)

- CEBRA & Department of Agriculture and Water Resources

Eastern Australia Islands (New Zealand) (EAB?)

- Plant and Food Research & Ministry Primary Industries

Common Model Objectives

Generic Risk Models: may be applied to a range of:

- Threats
- Locations (Islands)
- Dispersal Pathways
- Spatial and Temporal scales

Common Model Objectives

Predict risk zones and likelihoods of establishment, which can be used to inform cost-effective surveillance measures;

Trial alternative resource allocation strategies (not explicit in WAB model, yet…); and

Identify knowledge gaps and provide sensitivity analysis to guide future data collection.

BN Support Tool

Takes inputs on the

– Likelihoods of threat presence, movements of commodities/people and carry rates, and

– Effectiveness of mitigation measures to limit the movement of threats and eradicate established populations (NAB and NZB).

End user presumed to be moderately proficient in BNs

Island surveillance

Goal: Detect threats on Pilbara islands before establish large uncontrollable population

PROBLEM

- ~600 islands
- Dozens of threats (flora and fauna)
- At least 6 dispersal pathways
  - Swim, raft, current, wind, hitchhike with recreational boaters or industry
- Limited data

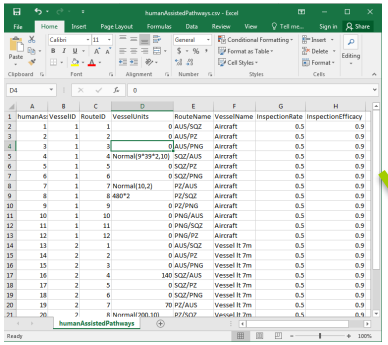
Challenges

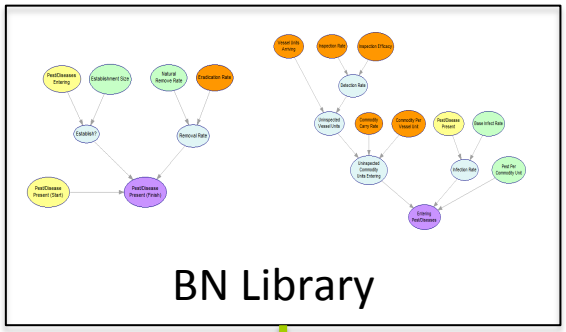
- Generic across threats
  - No obvious discretization
    - 2 Cats versus 1,000 Buffel grass seeds.
    - Small values and large volumes matter
- Generic across spatial/temporal scales
  - Issues with scaling up
    - Limitation with existing OOBN tools
      - Auto generating / connecting instantiations
      - Inference

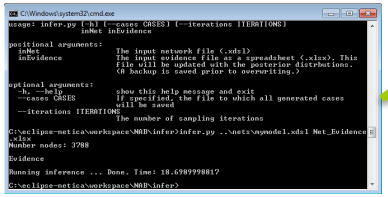
Practical Solutions

- Discretization
  - Could generate discretization for each threat class
  - Auto discretize (AgenaRisk)
  - Avoid discretization altogether (GeNIe Equation nodes)
    - Means we lose ability to perform fast exact updating
- Scaling up
  - Allow user to specify high level problem definition
  - Support tool to create the BN(s), given the definition

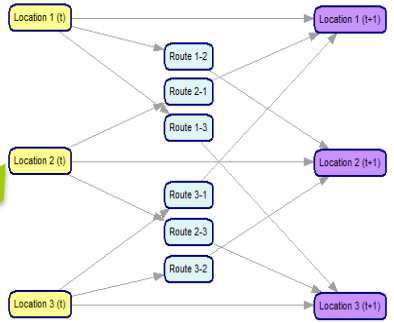
BN Support Tool Architecture

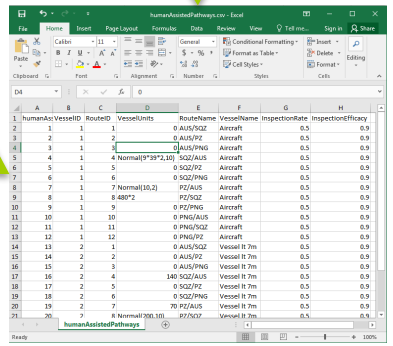


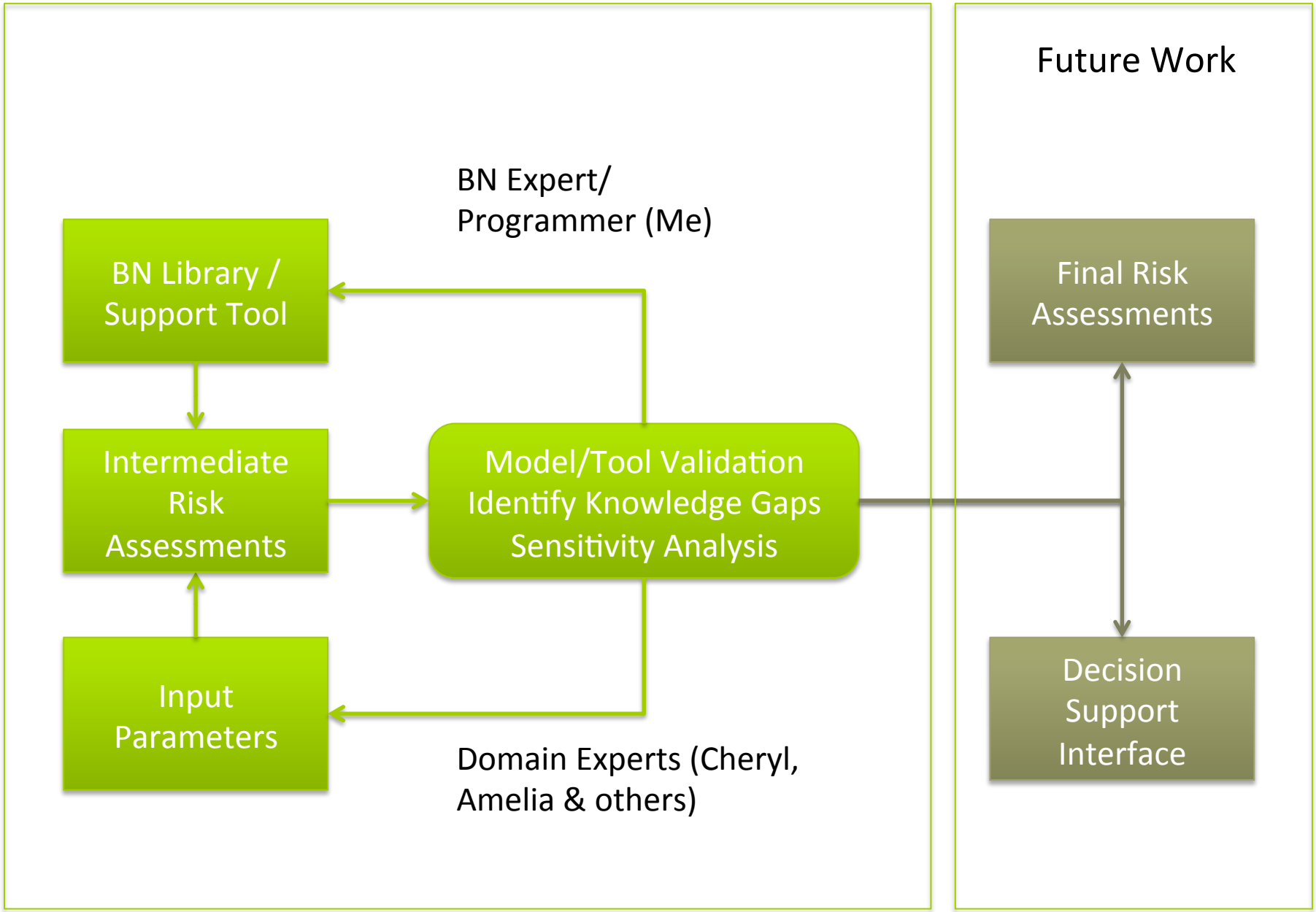


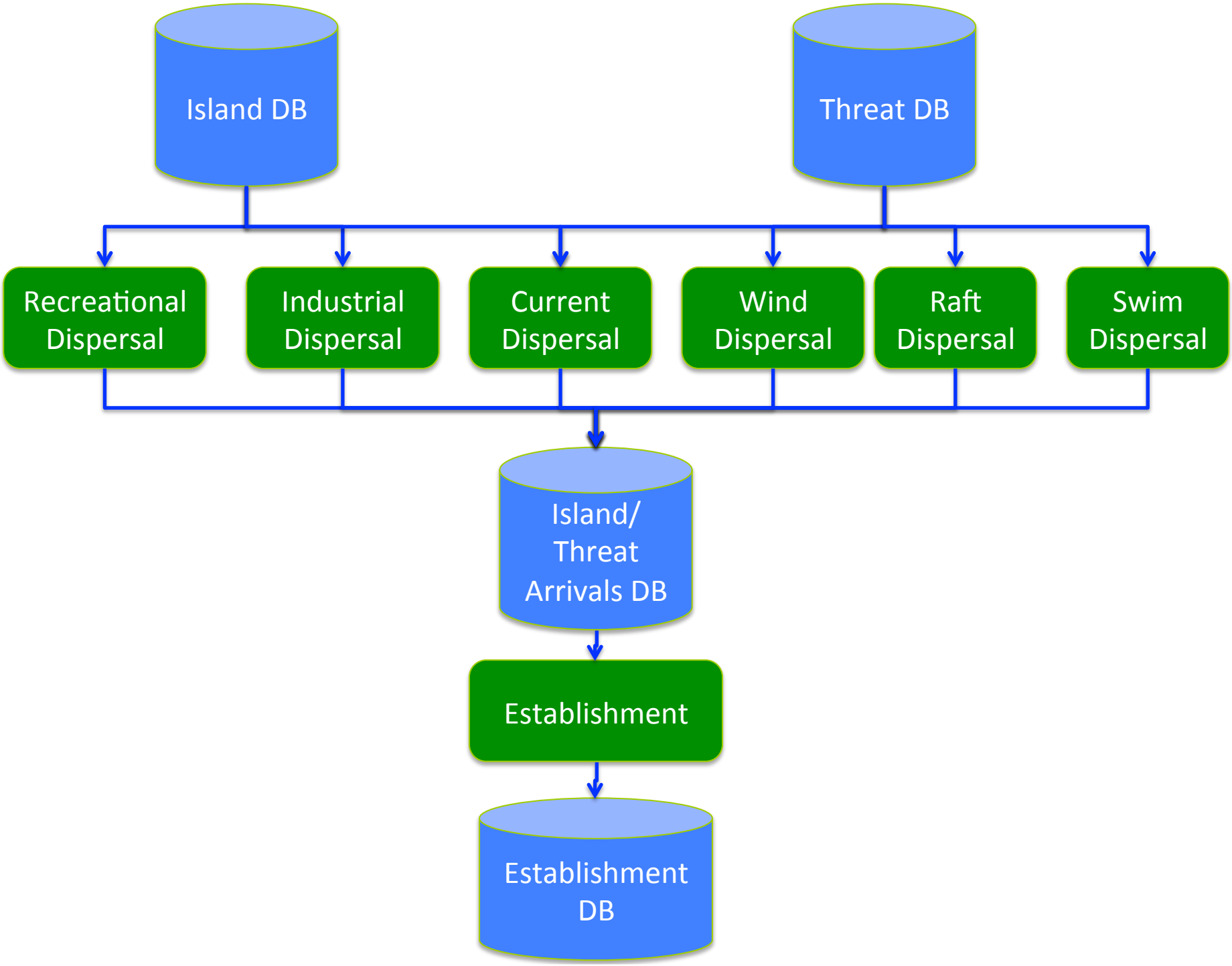


Support Tool

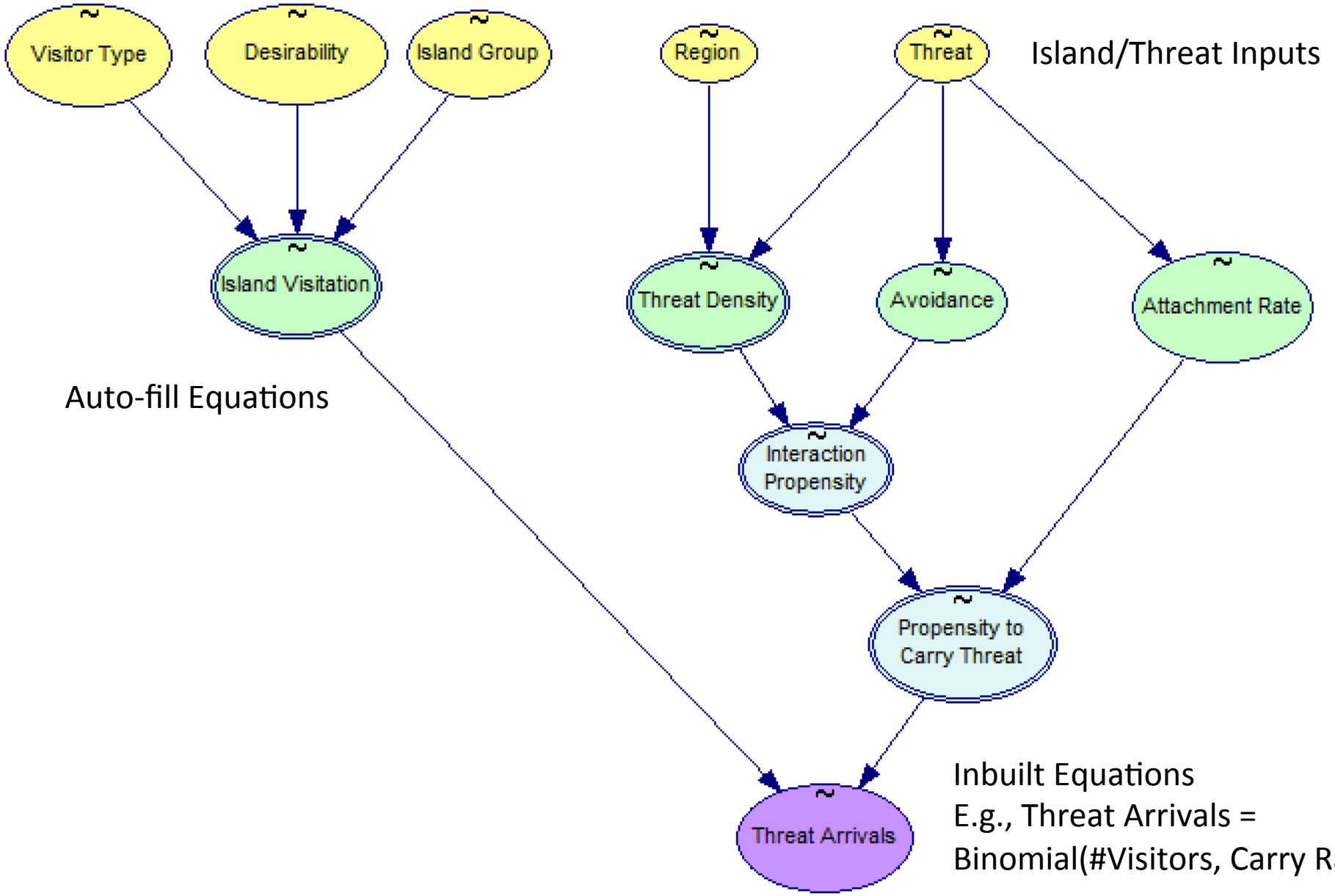




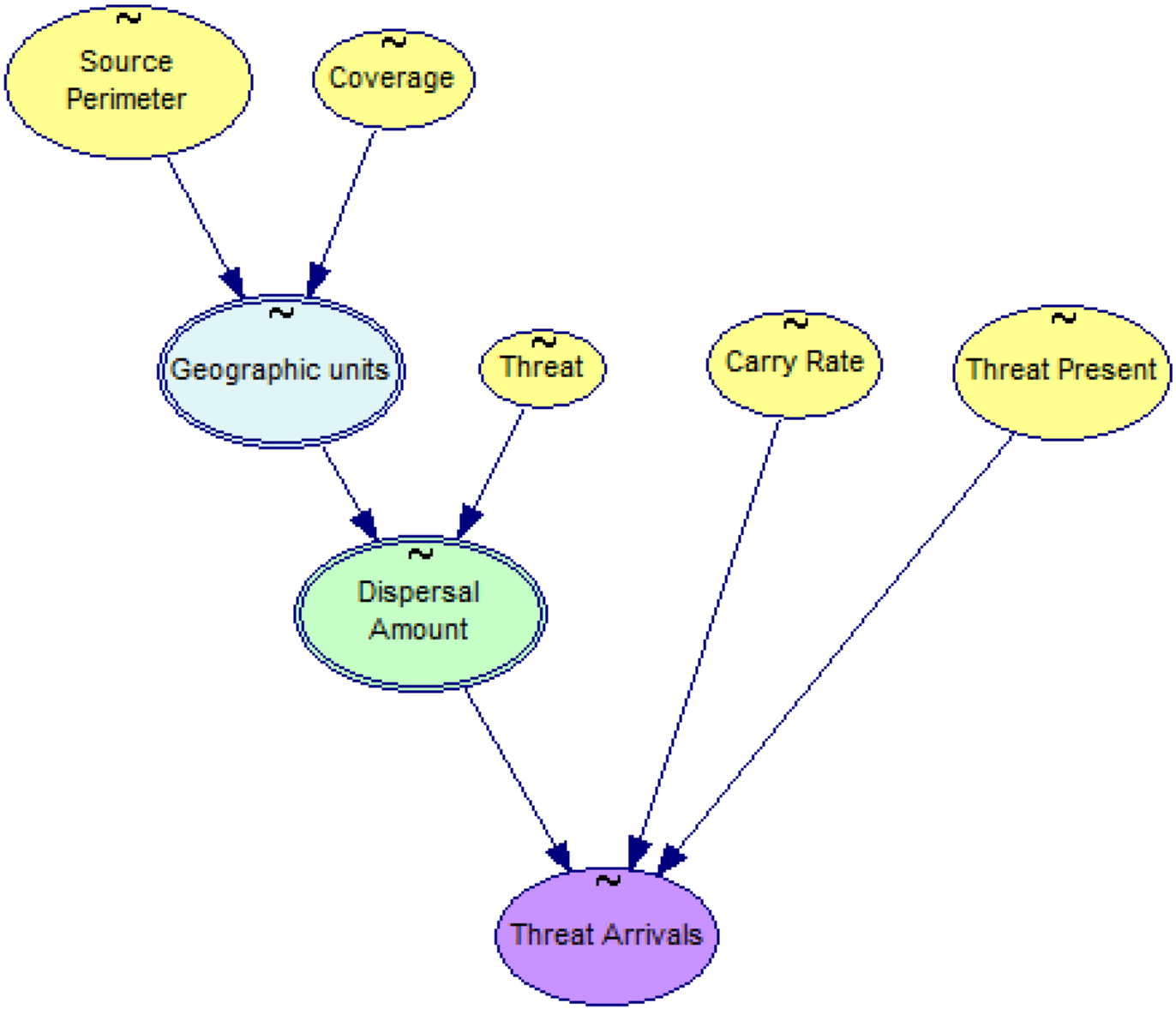

Future Work
BN Expert/
Programmer (Me)
BN Library /
Support Tool
Intermediate
Risk
Assessments
Input
Parameters
Model/Tool Validation
Identify Knowledge Gaps
Sensitivity Analysis
Domain Experts (Cheryl,
Amelia & others)
Final Risk
Assessments
Decision
Support
Interface


Island DB
Threat DB
Recreational Dispersal
Industrial Dispersal
Current Dispersal
Wind Dispersal
Raft Dispersal
Swim Dispersal
Island/ Threat Arrivals DB
Establishment
Establishment DB

Recreation Assisted Dispersal (Flora)



Current Dispersal (Flora)



Island DB

ISLANDID	NAME	ISLAND_GRO	REGION	ACCOM	CORAL	BEACH	CULTURAL	FISHING	SHELTERED	INDUSTRIALF	MACHUSE	INDUSTRYVIS	DISTURBANC	INFRASTRUC	PERIMETER	SIZE	ML_DIST
1	BEDOUT	PORT_HEDLA	PORT_HEDLA	NO	YES	NO	YES	NO	NO	ACTIVE	AIRCRAFT	4	1	1	2962.35	41.26	40290.47
2	NORTH_TUR	PORT_HEDLA	PORT_HEDLA	NO	NO	NO	NO	YES	NO	NONE	NONE	0	0	0	3346.28	65.98	18456.42
3	COHEN	KARRATHA	KARRATHA	NO	YES	YES	NO	YES	NO	NONE	NONE	0	1	0	1751.78	12.032982	15264.46
4	KEAST	KARRATHA	KARRATHA	NO	YES	YES	NO	YES	YES	NONE	NONE	0	0	0	4320.15	51.305951	13941.37
5	COLLIER_RO	KARRATHA	KARRATHA	NO	YES	YES	NO	YES	YES	NONE	NONE	0	1	0	3537.18	36.012243	12508.508
6	COLLIER_RO	KARRATHA	KARRATHA	NO	YES	YES	NO	YES	YES	NONE	NONE	0	0	0	2355.23	28.059706	12425.334
7	NORTH_GIDI	KARRATHA	KARRATHA	NO	YES	YES	NO	YES	YES	NONE	NONE	0	0	0	4855.82	67.351157	11824.387
8	MIDDLE_GID	KARRATHA	KARRATHA	NO	YES	YES	NO	YES	YES	NONE	NONE	0	1	0	9717	232.152895	9245.642
9	HAUY	KARRATHA	KARRATHA	NO	YES	YES	NO	YES	NO	NONE	NONE	0	0	0	6857.2	108.901417	14080.078
11	GIDLEY	KARRATHA	KARRATHA	NO	YES	YES	YES	YES	YES	NONE	NONE	0	1	0	20717.04	856.31949	6111.411
12	WILCOX	KARRATHA	KARRATHA	NO	YES	YES	NO	YES	YES	NONE	NONE	0	0	0	441.98	1.242777	7897.293
13	LADY_NORA	KARRATHA	KARRATHA	NO	YES	YES	NO	YES	YES	NONE	NONE	0	0	0	3453.73	32.38304	19496.533
14	ELPHICK_NO	KARRATHA	KARRATHA	NO	YES	YES	NO	YES	YES	NONE	NONE	0	0	0	2544.08	26.476751	19337.744
15	KENDREW	KARRATHA	KARRATHA	NO	YES	YES	NO	YES	NO	NONE	NONE	0	1	0	1465.8	10.607608	25943.811
16	ROSEMARY	KARRATHA	KARRATHA	YES	YES	YES	YES	YES	YES	ACTIVE	AIRCRAFT	4	0	0	19634.15	1122.1168	19822.476
17	ANGEL	KARRATHA	KARRATHA	NO	YES	YES	YES	YES	YES	NONE	NONE	0	0	0	18373.01	925.74926	1638.518
18	DOLPHIN	KARRATHA	KARRATHA	NO	YES	YES	YES	YES	YES	NONE	NONE	0	1	0	45260.33	3299.99869	408.992
19	MALUS_LAR	KARRATHA	KARRATHA	YES	YES	YES	YES	YES	YES	ACTIVE	AIRCRAFT	4	1	0	9500.1	217.692063	11177.753
20	GOODWYN	KARRATHA	KARRATHA	NO	YES	YES	NO	YES	YES	NONE	NONE	0	1	0	3174.75	30.690119	20880.476
21	WHITTAKER	KARRATHA	KARRATHA	NO	YES	YES	YES	YES	YES	NONE	NONE	0	1	0	3168.55	28.963437	10426.141
22	WEST_LEWIS	KARRATHA	KARRATHA	YES	YES	YES	YES	YES	YES	NONE	NONE	0	0	0	33304.18	1982.11499	9040.005
23	ENDERBY	KARRATHA	KARRATHA	YES	YES	YES	YES	YES	YES	NONE	NONE	0	0	0	52376.81	3240.85747	12666.675
24	EAST_LEWIS	KARRATHA	KARRATHA	YES	YES	YES	YES	YES	YES	NONE	NONE	0	1	0	18410.48	992.666855	5122.106
25	EAGLEHAWK	KARRATHA	KARRATHA	NO	YES	YES	NO	YES	NO	NONE	NONE	0	1	0	5979.6	138.505537	12392.87
48	NE_REGNAR	KARRATHA	KARRATHA	NO	YES	YES	NO	YES	NO	NONE	NONE	0	1	0	3244.64	46.332275	7055.097
51	PRESTON	KARRATHA	KARRATHA	NO	YES	YES	YES	YES	NO	ACTIVE	ALL	232800	1	0	1031.04	3.775201	1139.276
104	TOZER	KARRATHA	KARRATHA	NO	YES	YES	YES	YES	YES	NONE	NONE	0	0	0	3277.86	36.522887	6725.849
118	BRIGADIER	KARRATHA	KARRATHA	NO	YES	YES	NO	YES	NO	NONE	NONE	0	1	0	1821.38	14.285944	21781.03
123	CONZINC	KARRATHA	KARRATHA	NO	YES	YES	YES	YES	YES	NONE	NONE	0	1	0	1753.99	14.911896	2246.506
132	EAST_GOOD	KARRATHA	KARRATHA	NO	YES	YES	NO	YES	NO	NONE	NONE	0	1	0	2352.26	23.235673	20104.243
133	EGRET	KARRATHA	KARRATHA	NO	YES	YES	NO	YES	NO	NONE	NONE	0	0	0	713.76	2.815141	14617.292
145	BEARE	KARRATHA	KARRATHA	NO	YES	YES	NO	YES	NO	NONE	NONE	0	0	0	907.45	3.415314	20742.69
149	HAYCOCK	KARRATHA	KARRATHA	NO	NO	YES	NO	YES	NO	NONE	NONE	0	1	0	451.78	1.290376	4133.569
156	SATELLITE_R	KARRATHA	KARRATHA	NO	NO	YES	NO	YES	NO	NONE	NONE	0	1	0	485.18	1.273103	20648.399

Visitation Equation

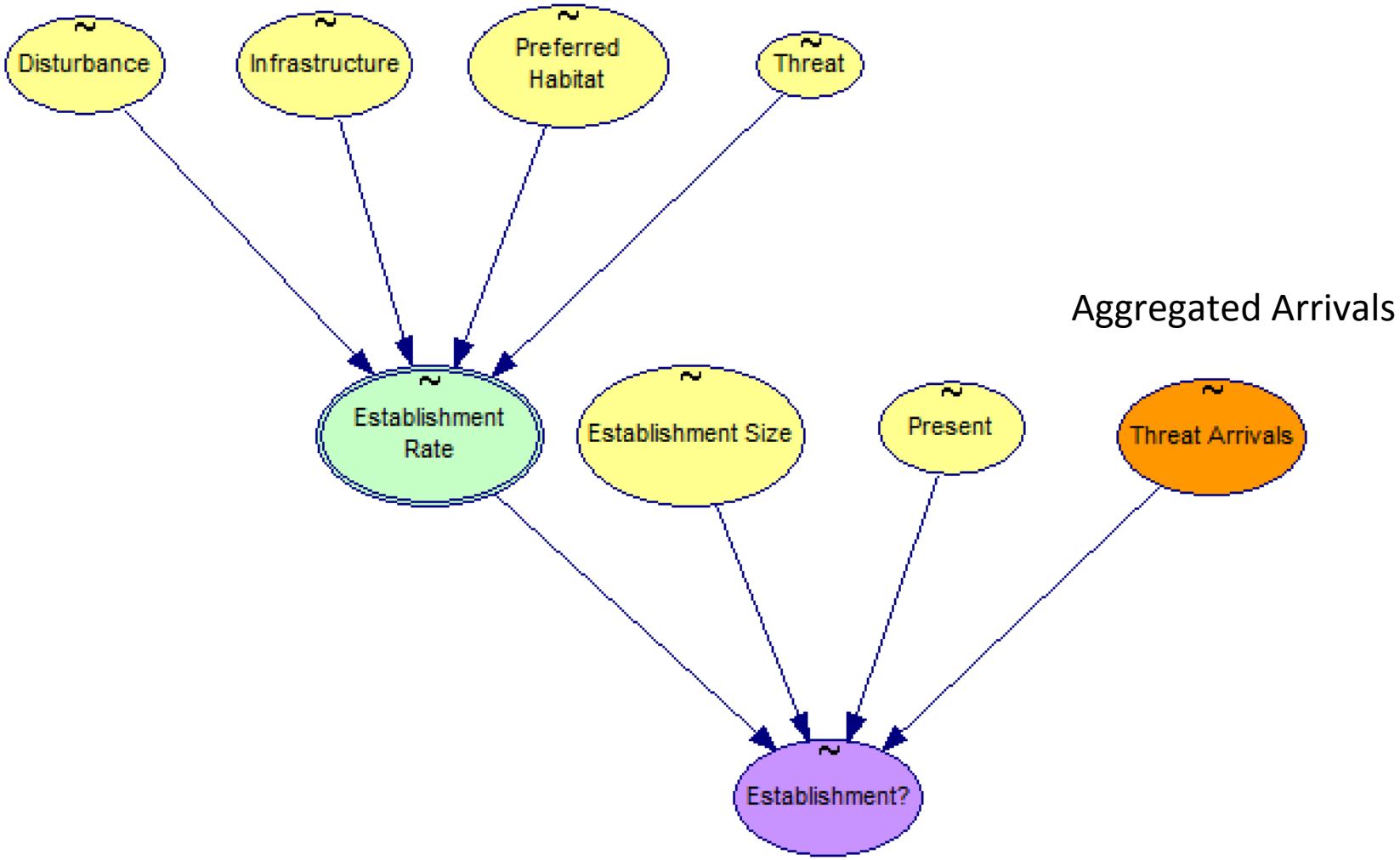
VISITATIONID	DESIRABILITY	VISITORTYPE	EXMOUTH	KARRATHA	ONSLOW	PORT_HEDI	MONTEBEL
0	HIGH	ALL	Uniform(300,400)	Uniform(2000,3000)	Uniform(8	Uniform(11	Uniform(40
1	HIGH	ONLY_SMALL	Uniform(102.6,115)	Uniform(1026,1560)	Uniform(2	Uniform(41	Uniform(1
2	HIGH	ONLY_MED_BIG	Uniform(197.4,234)	Uniform(1973.9,2430.8)	Uniform(5	Uniform(79	Uniform(39
3	HIGH	ONLY_BIG	Uniform(23.2,25)	Uniform(232,354)	Uniform(6	Uniform(9.3	Uniform(31
4	MODERATE	ALL	Uniform(60,70	Uniform(500,600)	Uniform(6	Uniform(24	Uniform(15
5	MODERATE	ONLY_SMALL	Uniform(21,22)	Uniform(171,201)	Uniform(2	Uniform(8.3	Uniform(0.1
6	MODERATE	ONLY_MED_BIG	Uniform(39.8,43)	Uniform(329,345)	Uniform(3	Uniform(15	Uniform(14
7	MODERATE	ONLY_BIG	Uniform(5,7)	Uniform(38.7,45.6)	Uniform(5	Uniform(1.5	Uniform(11
8	NOT	ALL	0	Uniform(1,2)	0	0	Uniform(30
9	NOT	ONLY_SMALL	0	0	0	0	Uniform(0.1
10	NOT	ONLY_MED_BIG	0	0	0	0	Uniform(29
11	NOT	ONLY_BIG	0	0	0	0	Uniform(23

Visitation = If(And(Desirability=0, VisitorType=0, Region=0), Uniform(300,400),
If(And(Desirability=0, VisitorType=0, Region=1), Uniform(2000,3000),
…))

Arrivals

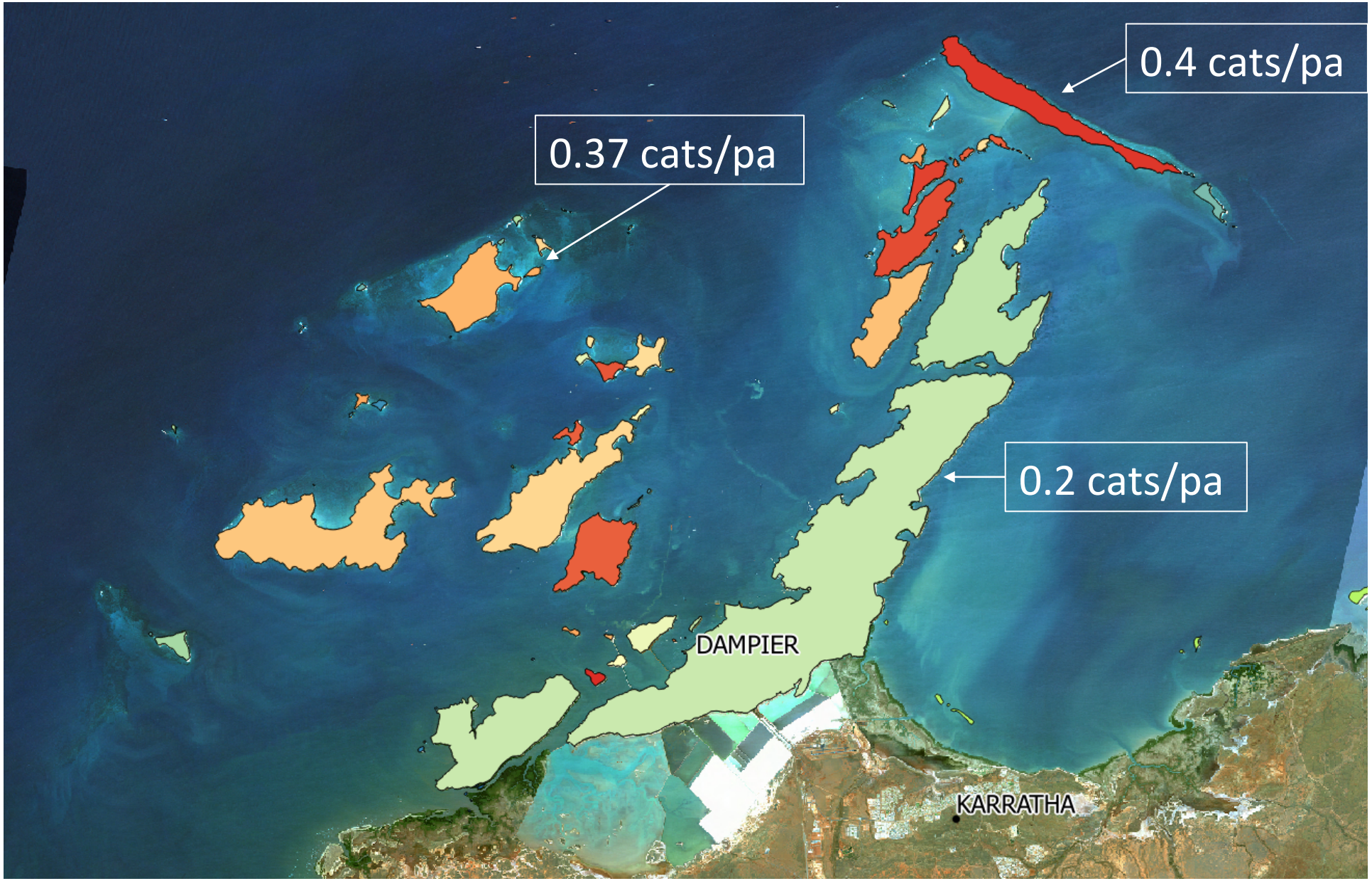
NAME	RECFLORA	RECFAUNA	INDUSTRY	RAFT	CURRENT	WIND	SWIM	CURRENTSUI	WINDSUMM	SWIMSUMM	TOTAL	TOTALHISTO
BEDOUT/MUS_MUSCULUS	[0.0, 0.0]	[0.0, 0.0]	[0.00100000	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.003, 0.054	{}	{}	{ML=0.003}	[0.00400000	[0.996, 0.004
BEDOUT/RATTUS_RATTUS	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.04200000	{}	{}	{COLLIER_RC	[0.04200000	[0.96, 0.038,
BEDOUT/RUBY_DOCK	[0.0, 0.0]	[0.0, 0.0]	[0.00500000	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{}	[0.00500000	[0.995, 0.005
BEDOUT/BUFFEL	[0.0, 0.0]	[0.0, 0.0]	[0.00700000	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{}	[0.00700000	[0.993, 0.007
BEDOUT/BOS_TAURUS	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{ML=0.0}	[0.0, 0.0]	[1.0]
BEDOUT/CANIS_FAMILIARIS	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.00400000	{}	{}	{DOLPHIN=0.	[0.00400000	[0.996, 0.004
BEDOUT/EQUUS_CABALLUS	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{ML=0.0}	[0.0, 0.0]	[1.0]
BEDOUT/FELIS_CATUS	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{GIDLEY=0.0,	[0.0, 0.0]	[1.0]
BEDOUT/ORYCTOLAGUS_CUNI	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{MISTAKEN=(	[0.0, 0.0]	[1.0]
BEDOUT/VULPES_VULPES	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.00899999	{}	{}	{ML=0.0089	[0.00899999	[0.991, 0.009
BEDOUT/RHINELLA_MARINA	[0.0, 0.0]	[0.0, 0.0]	[0.00100000	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{}	[0.00100000	[0.999, 0.001
BEDOUT/PHEIDOLE_MEGACEPI	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{ML=0.0}	[0.0, 0.0]	[1.0]
BEDOUT/COLUMBA_LIVIA	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{ML=0.0}	[0.0, 0.0]	[1.0]
BEDOUT/HEMIDACTYLUS_FREN	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{ML=0.0}	[0.0, 0.0]	[1.0]
NORTH_TURTLE/MUS_MUSCUI	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.00299999	[0.0, 0.0]	[0.0, 0.0]	[0.00200000	{}	{}	{ML=0.0020(	[0.005, 0.095	[0.995, 0.005
NORTH_TURTLE/RATTUS_RATT	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.04600000	{}	{}	{COLLIER_RC	[0.04600000	[0.954, 0.046
NORTH_TURTLE/RUBY_DOCK	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{}	[0.0, 0.0]	[1.0]
NORTH_TURTLE/BUFFEL	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{}	[0.0, 0.0]	[1.0]
NORTH_TURTLE/BOS_TAURUS	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.00100000	{}	{}	{ML=0.0010(	[0.00100000	[0.999, 0.001
NORTH_TURTLE/CANIS_FAMILI	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.00400000	{}	{}	{DOLPHIN=0.	[0.00400000	[0.996, 0.004
NORTH_TURTLE/EQUUS_CABA	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{ML=0.0}	[0.0, 0.0]	[1.0]
NORTH_TURTLE/FELIS_CATUS	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{GIDLEY=0.0,	[0.0, 0.0]	[1.0]
NORTH_TURTLE/ORYCTOLAGU	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{MISTAKEN=(	[0.0, 0.0]	[1.0]
NORTH_TURTLE/VULPES_VULP	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.00899999	{}	{}	{ML=0.0089	[0.00899999	[0.991, 0.009
NORTH_TURTLE/RHINELLA_MA	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{}	[0.0, 0.0]	[1.0]
NORTH_TURTLE/PHEIDOLE_ME	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{ML=0.0}	[0.0, 0.0]	[1.0]
NORTH_TURTLE/COLUMBA_LIV	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{ML=0.0}	[0.0, 0.0]	[1.0]
NORTH_TURTLE/HEMIDACTYLU	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{ML=0.0}	[0.0, 0.0]	[1.0]
COHEN/MUS_MUSCULUS	[0.0, 0.0]	[11.5730000	[0.0, 0.0]	[0.00199999	[0.0, 0.0]	[0.0, 0.0]	[0.00400000	{}	{}	{ML=0.0040(	[11.5790000	[0.002, 0.003
COHEN/RATTUS_RATTUS	[0.0, 0.0]	[8.77999999	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.05200000	{}	{}	{COLLIER_RC	[8.83199999	[0.018, 0.021
COHEN/RUBY_DOCK	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{}	[0.0, 0.0]	[1.0]
COHEN/BUFFEL	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{}	[0.0, 0.0]	[1.0]
COHEN/BOS_TAURUS	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	{}	{}	{ML=0.0}	[0.0, 0.0]	[1.0]

Establishment



Aggregated Arrivals

Mean arrival per annum - cats



What's next? Model validation!

- Garbage in – garbage out!
- Vague inputs for dispersal by industry
- What is the propagule pressure out of existing populations?
- Compare results against reality.






Any questions?