PERFORMANCE MEASURE INFORMATION SHEET #14

REVELSTOKE REACH: WETLAND ECOLOGICAL PRODUCTIVITY

Objective / Location	Performance Measure	Units	Description	MSIC
Wetland Productivity/ Revelstoke Reach	Wetland Productivity	Duration (# weeks flooded)	Reports on number of flooded weeks that four significant wetlands within Revelstoke Reach are inundated	10%
		Depth (metres)	Reports on depth of inundation at four significant wetlands within Revelstoke Reach.	10%

Description

The Revelstoke Wetlands is unique in that it comprises the largest known area of waterbird habitat within the impounded waters of the Columbia River. It provides important wetland habitat for 213 birds species (84 species of waterbirds, 21 birds of prey, and 108 species of land birds), as well as habitat for migratory, breeding and wintering birds, important breeding habitat for amphibians and reptiles, and important wintering habitat for ungulates. This includes a number of resident provincially red- and blue-listed species such as the Great Blue Heron, Western Toad and Painted Turtle.

The spatial extent, timing and duration of flooding of the Revelstoke Reach of Arrow Lakes Reservoir are important factors that determine the ecological productivity of the wetlands. Prolonged flooding (and associated changes in water temperature and nutrients) of the wetlands is likely to affect the composition and species richness of wetland vegetation, habitat function and use, and the abundance and distribution of invertebrate communities, which are important food sources for migratory birds and resident wetland dependant species. This is particularly important for migratory birds that rely on the Revelstoke Wetlands as a stop-over for resting and feeding to support their migration.

Performance Measures

Two performance measures were developed to account for how inundation is likely to affect important processes that drive wetland productivity (duration and depth of inundation). This was tracked for four significant wetland areas within Revelstoke Reach – Downie Marsh, Airport Marsh, Montana Slough and Cartier Marsh over the spring/early summer period (15 Mar– 21 Jul) and late summer/fall period (22 Jul – 7 Nov) (Figure 1). These seasonal periods are defined based on approximate start and end dates for various life history use patterns for wildlife species that are being monitored through BC Hydro's long-term, wildlife monitoring programs (D. Adama, BC Hydro, pers. comm.). The spring/early summer period captures use of the wetlands by spring waterfowl and songbird migration, song bird nesting, waterfowl brood rearing, amphibian breeding (i.e., western toad) and raptor nesting. The late summer/fall period captures fall songbird, shorebird and waterfowl migration.

Duration and depth of flooding were computed for specific elevations for each the four wetlands based on inundation statistics for the Revelstoke Reach area, which take into account simulated reservoir elevation, local inflow and discharge releases from Revelstoke Dam for the period 1964-1973. The elevations of Montana Slough and Cartier Bay are based on survey elevations,

while those for Downie Marsh and Airport Marsh are close approximations based on available orthophotos, the Digital Elevation Model for Revelstoke Reach, and field observations (D. Adama, pers. comm., F. Maltby, pers. comm.).

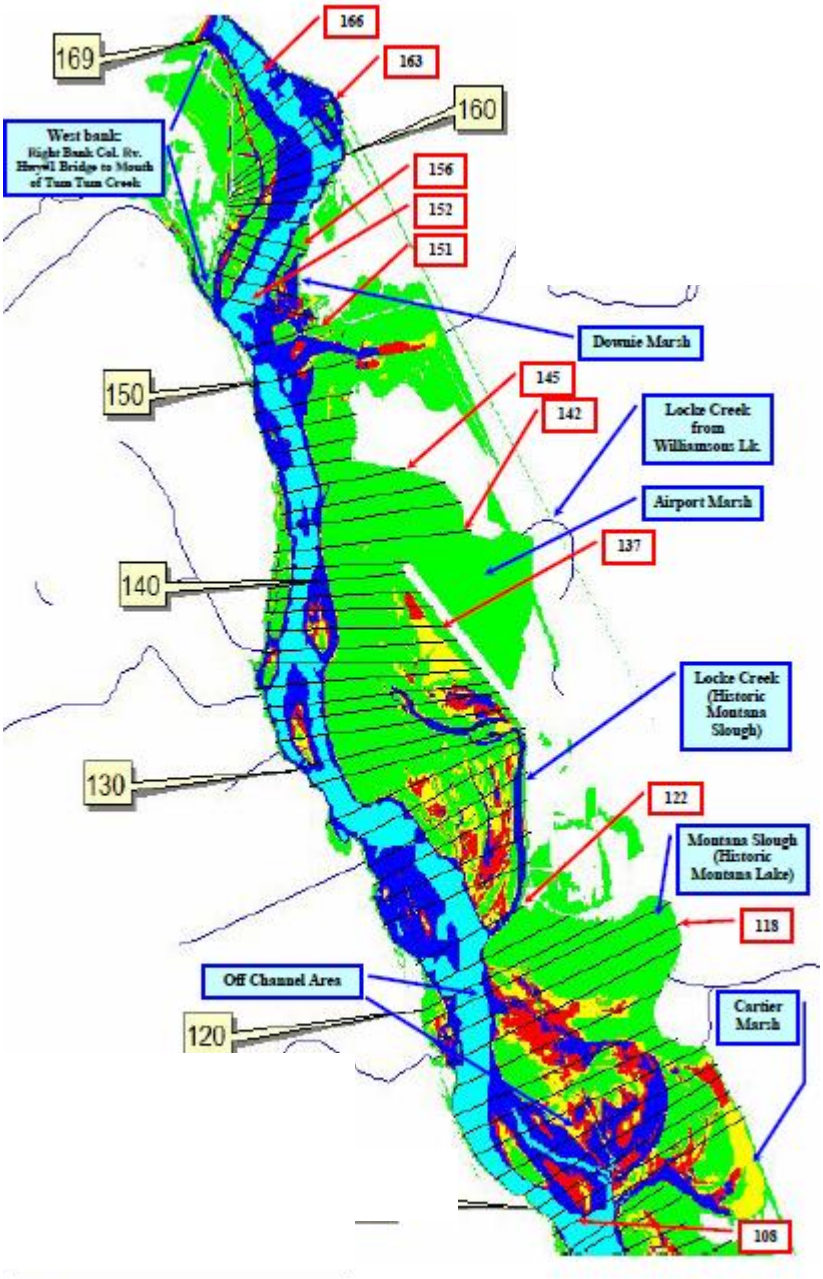


Figure 1. Map of Revelstoke Reach showing Locations of the Four Significant Wetland Areas (Downie Marsh, Airport Marsh, Montana Slough and Cartier Marsh)

Base Elevations of Four Significant Wetlands

Wetland Area	Elevation (m)
Downie Marsh	435.6
Airport Marsh	438.3
Montana Slough	436.3
Cartier Bay	433.8

Calculations

The most recent version of the HEC-RAS model for the mid Columbia River was used to estimate water surface elevations at each of the key wetland areas. (Refer to the Mid Columbia River Fish Habitat PM Sheet for a description of the HEC-RAS model).The model is driven by Arrow Reservoir elevations (at Fauquier), discharge from Revelstoke Dam, and estimated local inflows. Water surface elevations are predicted for every week of the year from 1964 to 1973 based on the average local inflow by week, the average reservoir elevation by week, and the maximum hourly discharge from Revelstoke Dam by week.

The effects of water surface elevation on wetland productivity are modeled by predicting the number of weeks over the spring/summer and summer/fall periods during which each of the wetland elevations is inundated, and the magnitude of flooding at each wetland. As the HEC-RAS model calculates the elevation at each cross section as a function of both reservoir elevations and dam discharges, areas closer to the dam (e.g., Downie) can experience greater flooding at any given time than those further downstream (e.g., Cartier) even though it has a slightly higher base elevation (Figure 1).

Key Assumptions and Uncertainties

- Each scenario is simulated using the same set of system constraints, input assumptions (e.g., load forecasts) and historic basin inflows (1964-1973).
- Assumes that the seasons of use and elevations of each wetland are correct.
- Assumes that the seasonal range of water elevations within each wetlands that fall outside of the influence of the reservoir are consistent in timing and magnitude.

Results

Downie Marsh

During the spring/early summer period, none of the scenarios would perform significantly different in terms of duration or magnitude of inundation of the Downie Marsh. However, Scenario D (no NTS) would cause the marsh to be inundated significantly more (i.e., greater flooded depth) during the late summer/fall than the “with NTS” scenarios (Figure 2). Duration of inundation would be identical across the scenarios, as the marsh would be flooded for the full 15-week period.

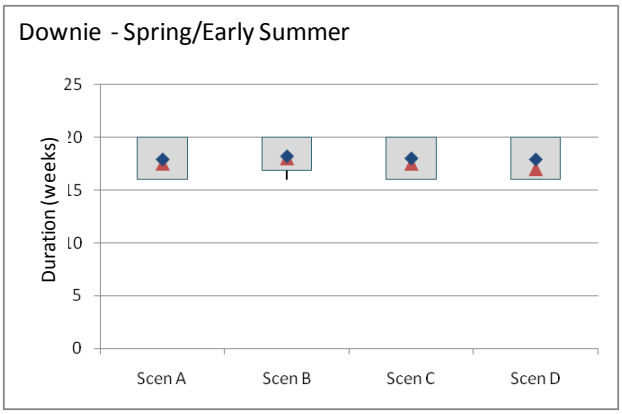
Airport Marsh
On average, Scenario D would cause Airport Marsh to be inundated longer and to a greater extent than Scenarios A, B and C during both the early spring/summer and late summer/fall periods (Figure 3).

Montana Slough
All of the scenarios would perform similarly in terms of duration and extent of flooding of Montana Slough during the spring/early summer period (Figure 4). However, during the late summer/fall period, Scenario D would keep the reservoir higher than the "with NTS" scenarios causing a significantly greater number of flooded weeks and depth of flooding.

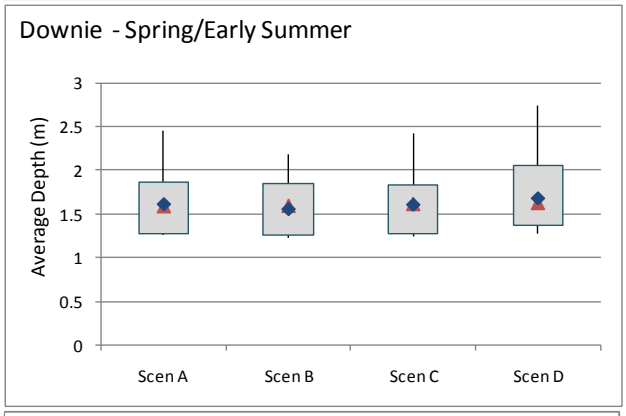
Cartier Bay
During the spring/early summer period, all of the scenarios would perform similarly in term of duration and depth of inundation of Cartier Bay. However, Scenario D would cause a significantly greater number of flooded weeks and depth of flooding during the late summer/fall period (Figure 5). Scenario A (4.5 MAF) would perform best at minimizing the duration of flooding of Cartier Bay, while Scenario B (3.0 MAF) would perform best at minimizing the depth of flooding.

Figure 2. Downie Marsh - Flooded Duration (weeks) & Average Flooded Depth (m)

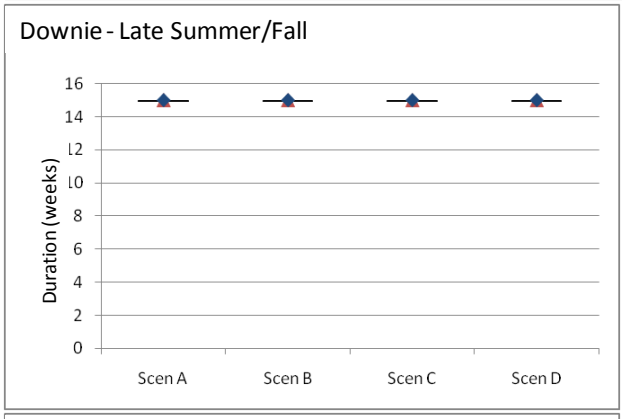
	Scen A	Scen B	Scen C	Scen D
Max	20.0	20.0	20.0	20.0
90th	20.0	20.0	20.0	20.0
Mean	17.9	18.2	18.0	17.9
Med	17.5	18.0	17.5	17.0
10th	16.0	16.9	16.0	16.0
Min	16.0	16.0	16.0	16.0



	Scen A	Scen B	Scen C	Scen D
Max	2.5	2.2	2.4	2.7
90th	1.9	1.8	1.8	2.1
Mean	1.6	1.6	1.6	1.7
Med	1.6	1.6	1.6	1.6
10th	1.3	1.3	1.3	1.4
Min	1.3	1.2	1.3	1.3



	Scen A	Scen B	Scen C	Scen D
Max	15.0	15.0	15.0	15.0
90th	15.0	15.0	15.0	15.0
Mean	15.0	15.0	15.0	15.0
Med	15.0	15.0	15.0	15.0
10th	15.0	15.0	15.0	15.0
Min	15.0	15.0	15.0	15.0



	Scen A	Scen B	Scen C	Scen D
Max	1.6	1.6	1.6	2.8
90th	1.5	1.4	1.6	2.4
Mean	1.3	1.2	1.3	2.3
Med	1.2	1.2	1.3	2.3
10th	1.1	1.1	1.2	2.1
Min	1.0	1.0	1.0	1.9

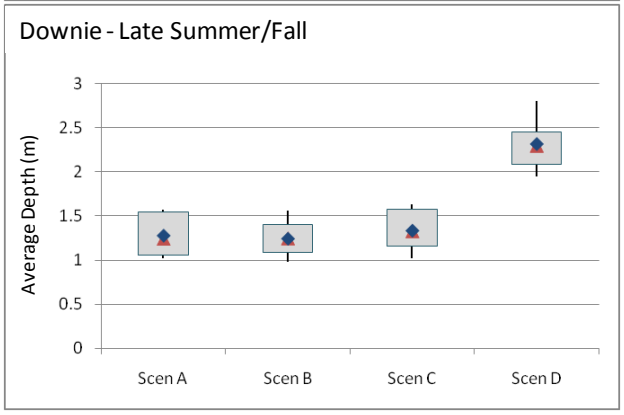
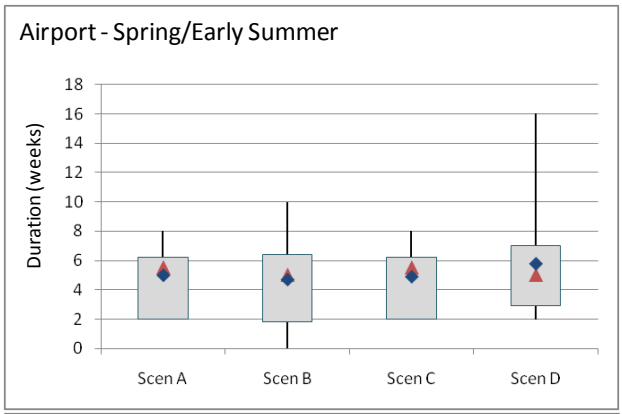
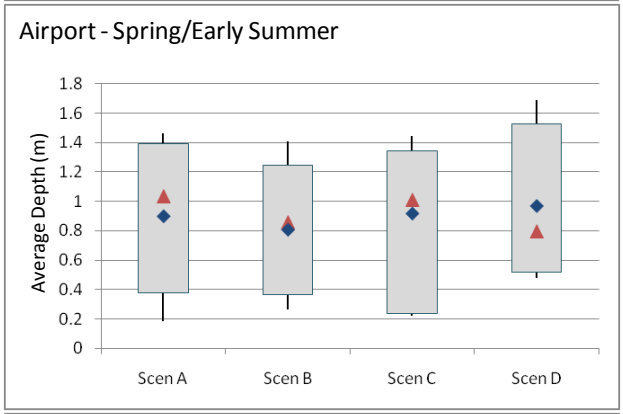


Figure 3. Airport Marsh - Flooded Duration (weeks) & Average Flooded Depth (m)

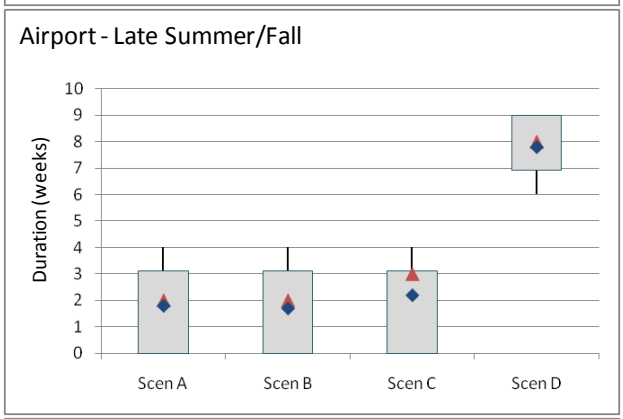
	Scen A	Scen B	Scen C	Scen D
Max	8.0	10.0	8.0	16.0
90th	6.2	6.4	6.2	7.0
Mean	5.0	4.7	4.9	5.8
Med	5.5	5.0	5.5	5.0
10th	2.0	1.8	2.0	2.9
Min	2.0	-	2.0	2.0



	Scen A	Scen B	Scen C	Scen D
Max	1.5	1.4	1.4	1.7
90th	1.4	1.2	1.3	1.5
Mean	0.9	0.8	0.9	1.0
Med	1.0	0.9	1.0	0.8
10th	0.4	0.4	0.2	0.5
Min	0.2	0.3	0.2	0.5



	Scen A	Scen B	Scen C	Scen D
Max	4.0	4.0	4.0	9.0
90th	3.1	3.1	3.1	9.0
Mean	1.8	1.7	2.2	7.8
Med	2.0	2.0	3.0	8.0
10th	-	-	-	6.9
Min	-	-	-	6.0



	Scen A	Scen B	Scen C	Scen D
Max	1.4	1.0	1.5	1.3
90th	1.0	0.7	1.1	1.2
Mean	0.5	0.4	0.7	1.0
Med	0.4	0.3	0.5	1.1
10th	0.2	0.2	0.3	0.7
Min	0.1	0.1	0.3	0.7

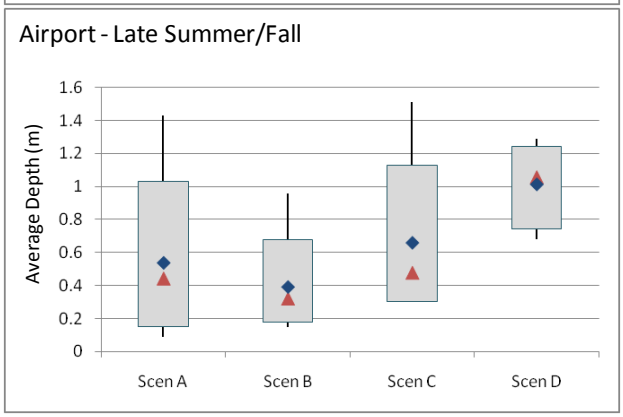
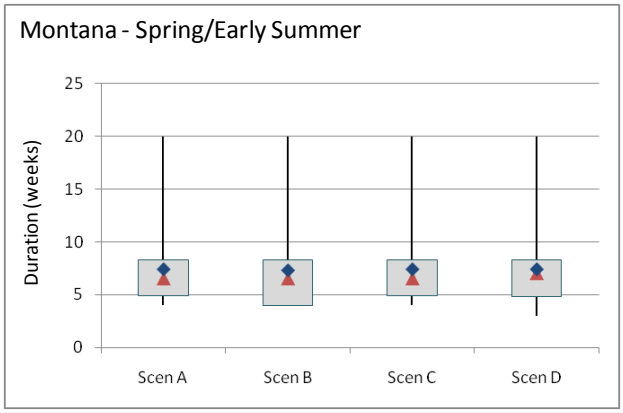
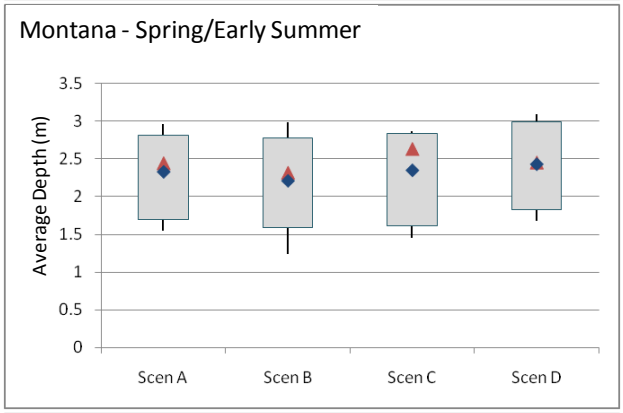


Figure 4. Montana Slough - Flooded Duration (weeks) & Average Flooded Depth (m). Red-shaded results carried forward into Consequence Table.

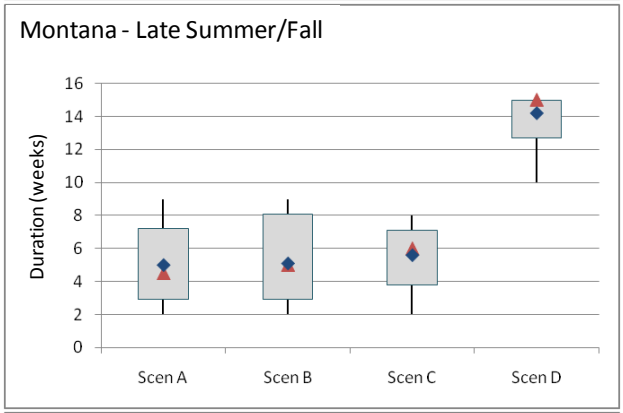
	Scen A	Scen B	Scen C	Scen D
Max	20.0	20.0	20.0	20.0
90th	8.3	8.3	8.3	8.3
Mean	7.4	7.3	7.4	7.4
Med	6.5	6.5	6.5	7.0
10th	4.9	4.0	4.9	4.8
Min	4.0	4.0	4.0	3.0



	Scen A	Scen B	Scen C	Scen D
Max	3.0	3.0	2.9	3.1
90th	2.8	2.8	2.8	3.0
Mean	2.3	2.2	2.3	2.4
Med	2.4	2.3	2.6	2.5
10th	1.7	1.6	1.6	1.8
Min	1.6	1.2	1.5	1.7



	Scen A	Scen B	Scen C	Scen D
Max	9.0	9.0	8.0	15.0
90th	7.2	8.1	7.1	15.0
Mean	5.0	5.1	5.6	14.2
Med	4.5	5.0	6.0	15.0
10th	2.9	2.9	3.8	12.7
Min	2.0	2.0	2.0	10.0



	Scen A	Scen B	Scen C	Scen D
Max	2.1	1.6	1.9	2.6
90th	1.8	1.6	1.8	2.6
Mean	1.4	1.2	1.4	2.1
Med	1.5	1.2	1.6	2.0
10th	0.9	0.7	0.7	1.9
Min	0.8	0.3	0.5	1.6

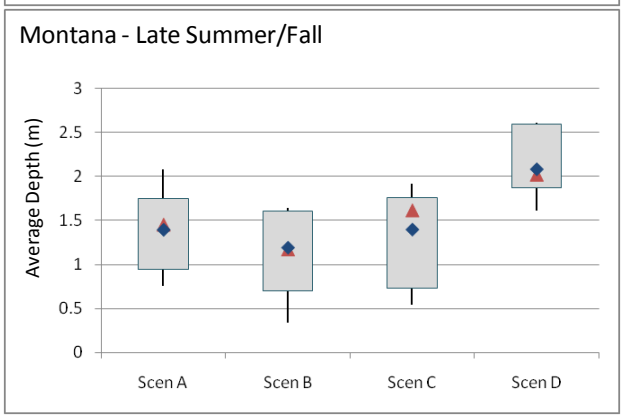
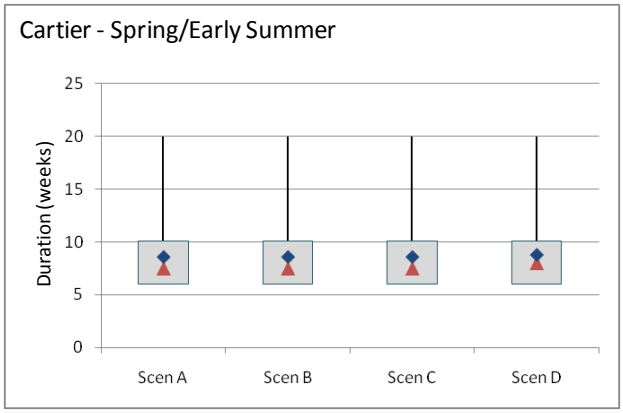
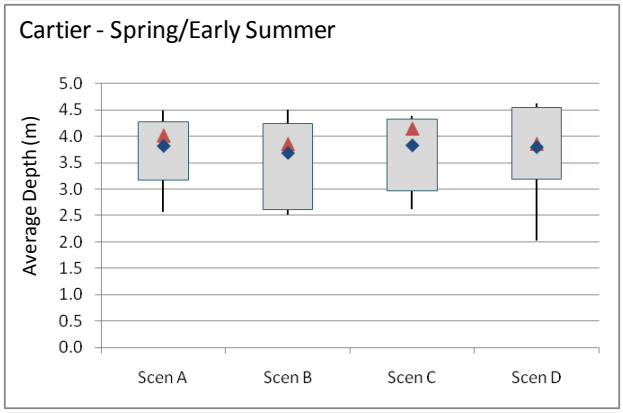


Figure 5. Cartier Bay - Flooded Duration (weeks) & Average Flooded Depth (m)

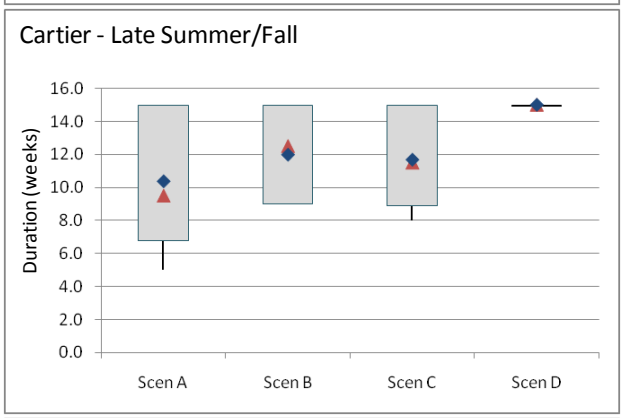
	Scen A	Scen B	Scen C	Scen D
Max	20.0	20.0	20.0	20.0
90th	10.1	10.1	10.1	10.1
Mean	8.6	8.6	8.6	8.8
Med	7.5	7.5	7.5	8.0
10th	6.0	6.0	6.0	6.0
Min	6.0	6.0	6.0	6.0



	Scen A	Scen B	Scen C	Scen D
Max	4.5	4.5	4.4	4.6
90th	4.3	4.2	4.3	4.5
Mean	3.8	3.7	3.8	3.8
Med	4.0	3.9	4.1	3.9
10th	3.2	2.6	3.0	3.2
Min	2.6	2.5	2.6	2.0



	Scen A	Scen B	Scen C	Scen D
Max	15.0	15.0	15.0	15.0
90th	15.0	15.0	15.0	15.0
Mean	10.4	12.0	11.7	15.0
Med	9.5	12.5	11.5	15.0
10th	6.8	9.0	8.9	15.0
Min	5.0	9.0	8.0	15.0



	Scen A	Scen B	Scen C	Scen D
Max	2.5	2.6	2.6	4.6
90th	2.5	2.6	2.6	4.1
Mean	2.1	2.0	2.2	3.9
Med	2.2	2.0	2.3	3.9
10th	1.7	1.4	1.6	3.5
Min	1.5	1.1	1.2	3.4