

**HABITAT COMPENSATION, RESTORATION
AND CREATION IN THE FRASER RIVER
ESTUARY.**

***Are We Achieving a No-Net Loss of Fish
Habitat ?***

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Habitat Compensation, Restoration and Creation in the Fraser
River Estuary:

Are We Achieving a No-Net-Loss of Fish Habitat ?

by

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Map of Fraser River Estuary (FREMP Area) showing boundaries (dashed line) and location of the 15 Habitat Management Units (HMU).

- HMU 01: North Arm, Poplar Island to Boundary Bay.
- HMU 02: North Arm, Boundary Road to Arthur Laing Bridge.
- HMU 03: North Arm, Arthur Laing Bridge to McDonald Slough
- HMU 04: North Arm, McDonald Slough to Point Grey
- HMU 05: Middle Arm, Bridgeport to Swishwash Island
- HMU 06: Sturgeon Bank
- HMU 07: Roberts Bank
- HMU 08: Boundary Bay
- HMU 09: South Arm, Steveston to Deas Island
- HMU 10: South Arm, Deas Island to Annacis Island
- HMU 11: South Arm, Annacis Channel
- HMU 12: South Arm, City Reach and Annieville Channel
- HMU 13: South Arm, Annacis Island to Port Mann Bridge
- HMU 14: South Arm, Port Mann Bridge to Kanaka Creek
- HMU 15: Pitt River

ABSTRACT

This report provides data on all habitat compensation, restoration and creation projects undertaken in the Fraser River Estuary between 1983 and 1993. The data were computerized and include colour photographs and digitized location maps for each project site. Data were summarized to determine whether we are achieving a no net loss (NNL) of subtidal, mudflat, marsh and riparian habitat in connection with habitat compensation. With respect to subtidal habitat, the NNL Principle has generally not been applied. Nevertheless, 90 ha of shallow subtidal mudflat/sandflat has been lost on Roberts Bank. The NNL Principle has not been achieved for mud/sandflat habitat because a number of compensation projects did not adequately replace lost mudflat. Compensation for the loss of brackish-freshwater marsh has been successfully achieved; however, a net deficit exists for saltmarsh. The NNL Principle has not been achieved for riparian habitat. Since riparian habitat losses are expressed in linear metres, the data significantly underestimated the actual habitat loss. Several habitat restoration and creation projects have resulted in a net gain of habitat in the Estuary. A group of aquatic habitat specialists identified problems with specific habitat projects and provided the following recommendations:

- A much more rigorous process of project approval, construction and monitoring is required.
- The Habitat Compensation Agreement must be applied in all compensation cases.
- Regular updating of the Habitat Inventory Maps should be undertaken
- Habitat that is coded red and yellow must be protected more effectively.
- The long-term maintenance of debris barriers to protect habitat needs to be addressed.
- There must be an effective debris source control program downstream of Agassiz.
- There must be a stricter assessment and consultation process in cases where one type of habitat is proposed to be replaced with another type, or in an off-site location.
- There must be a general framework for biophysical monitoring.
- Habitat banking should be used for isolated projects less than 70 m² in size or impacts accumulated and the compensatory habitat placed in a larger site.
- Agencies must have continuity of knowledgeable technical staff that follow consistent guidelines of technically based and well defined procedures.
- Habitat remediation strategies must be clearly tied into the biophysical monitoring program.
- There is a need for more scientific study of controlled transplanting and natural colonization experiments.
- A more rigorous monitoring strategy including work on fish utilization and fish food organisms should be built into the monitoring requirements of all large projects.
- There must be specific instructions on donor site locations and the procedures used for obtaining transplant material and mitigating donor site impacts.

RÉSUMÉ

Le présent rapport fournit des données sur tous les projets de compensation, de remise en état et de création d'habitats entrepris dans l'estuaire du Fraser entre 1983 et 1993. Les données ont été informatisées et on trouve pour chaque site des photos couleur et des cartes numériques. On a résumé les données pour déterminer si la compensation des habitats permettait d'atteindre l'objectif d'aucune perte nette (APN) d'habitats de zone subtidale ou riveraine, de vasière et de marais. Le principe d'APN n'a généralement pas été appliqué aux habitats de zone subtidale. Cependant, 90 ha de vasière ou de platin de sable de zone subtidale peu profonde ont été perdus sur le banc Roberts. Le principe d'APN n'a pas été appliqué pour les habitats de vasière/platin de sable parce qu'un bon nombre des projets de compensation ne remplaçaient pas convenablement les vasières perdues. On a bien réussi à compenser la perte de marais d'eau saumâtre ou douce, mais il demeure un déficit net des marais salés. L'objectif d'APN n'a pas été atteint pour les habitats riverains. Comme, pour ce type d'habitats, les pertes sont exprimées en mètres linéaires, les données les sous-estiment considérablement. Plusieurs projets de remise en état et de création d'habitats se sont traduits par un gain net dans l'estuaire. Un groupe de spécialistes des habitats aquatiques a repéré des problèmes dans certains projets particuliers et formulé les recommandations suivantes :

- On devra suivre un processus beaucoup plus rigoureux pour l'approbation, la construction et la surveillance des projets.
- L'entente de compensation d'habitat devra être appliquée dans tous les cas de compensation.
- Il faudrait entreprendre une mise à jour régulière des cartes d'inventaire d'habitats.
- Il faudra protéger de manière plus efficace les habitats qui ont reçu les cotes rouge et jaune.
- Il faudra se pencher sur la question des barrières anti-débris pour protéger les habitats.
- Il doit y avoir un programme efficace de maîtrise des débris à la source en aval d'Agassiz.
- On devra prévoir un mécanisme plus strict d'évaluation et de consultation pour les cas où l'on propose de remplacer un type d'habitat par un autre, ou par un emplacement hors site.
- Il doit exister un cadre de surveillance biophysique.
- On devrait pratiquer la combinaison d'habitats pour les projets isolés de moins de 70 m² de superficie ou les impacts cumulés, et installer l'habitat compensatoire sur un site plus grand.
- Les organismes concernés doivent conserver une continuité de personnel technique compétent, qui applique des lignes directrices cohérentes concernant des méthodes bien définies à base technique.
- Les stratégies de restauration des habitats doivent être clairement intégrées au programme de surveillance biophysique.

- Il faudra effectuer d'autres études scientifiques mettant en jeu des expériences contrôlées de transplantation et de colonisation naturelle.
- Les exigences de tous les grands projets en matière de surveillance devraient comprendre une stratégie de surveillance plus rigoureuse incluant des travaux sur l'utilisation du poisson et les organismes dont se nourrit ce dernier.
- Il doit y avoir des instructions précises quant à l'emplacement des sites donneurs et aux techniques utilisées pour se procurer le matériel à transplanter et pour atténuer les impacts sur le site donneur.

PREFACE

Policy on Fish Habitat Management

One of the first milestones pertaining to fish habitat management in the Fraser River Estuary was the preparation of a report published in 1978 by the joint Canada-British Columbia, Habitat Work Group¹. This report described the vast losses of estuarine habitat over the past century and recommended some general habitat protection, conservation, restoration and enhancement options to remedy fish habitat losses.

In 1983, the Department of Fisheries and Oceans (DFO) issued a national discussion paper which outlined a habitat policy based on achieving a no-net-loss of the productive capacity of existing habitat. With the establishment of the Fraser River Habitat Management Unit in 1983, the principle of *No-Net-Loss* (NNL) as outlined in the national discussion paper was applied to all new projects in the Estuary.

The actual policy was advanced and published in 1986 as the *Policy on Fish Habitat Management* (DFO 1986)² which was designed to achieve a *Net Gain* of habitat for Canada's fisheries resources. Prior to official release of the policy, the NNL principle was being applied, tested and refined starting in 1983. Indeed, the refinement and improvement of the application of the NNL principle has been, and will continue to be, an ongoing process.

No Net Loss Principle

The Policy objective of a *Net Gain* of habitat is supported by three goals covering 1) conservation, 2) restoration and 3) development³ of fish habitat. The first goal is to prevent the further loss or damage of fish habitat through habitat conservation, implemented by using the NNL guiding principle. The application of this principle is commonly referred to as *habitat compensation*. Unavoidable habitat losses due to a development project are compensated by habitat replacement on a project-by-project basis. The habitat replacement typically involves habitat creation.

1 Habitat Work Group. 1978. Fraser River Study. Habitat. Government of Canada and Province of British Columbia.

2 Department of Fisheries & Oceans 1986. Policy for the Management of Fish Habitat. Communications Directorate, Fisheries and Oceans, Ottawa, Ontario.

3 Throughout this report, habitat development will be referred to as habitat creation. In reality, there can be no habitat creation on the historical floodplain. Present day habitat projects essentially restores or enhances the habitat that once occurred prior to diking, filling and draining of the floodplain in the last one hundred years of human settlement. However, for the purpose of this report, diked and filled habitat is considered a permanent loss, and therefore any habitat projects not occurring on existing natural habitat are considered to be habitat creation.

The other two goals (restoration and development) assist in the achievement of a Net Gain of habitat.

Habitat Compensation

The first preference of NNL is to maintain, without disruption, the natural productive capacity of the habitat by avoiding any habitat loss or alteration due to a proposed project or activity. If the proposed project or activity is located in a productive habitat, the proponent will be encouraged to find an alternative development site. However, should this not be feasible and the project is "in the public interest", then DFO will accede to satisfactorily designed compensatory actions such as: 1) like-for-like⁴ on-site compensation, 2) off-site replacement habitat, or 3) an increase in the productivity of existing habitat. These compensatory options are listed in order of preference and are often referred to as the *hierarchy of preference*.

The typical habitat replacement formula applied by DFO to the Fraser River estuary is as follows:

- For marsh habitat, a ratio of 2:1 is requested such that twice the area of the same type of habitat is replaced as is lost or damaged. This replacement ratio takes into account the time period required for a productive marsh to develop and the risk involved in successfully achieving this goal.
- For mudflat and riparian habitat, a ratio of 1:1 is used such that an equal amount of the same type of habitat lost or damaged is replaced. The riparian habitat is measured on a linear basis and having a minimum width of 5 metres.

Estuary Management Plan

The overall objectives of the 1986 Fish Habitat Management Policy is also achieved through the integration of resource plans with the planning processes of other jurisdictions such as the North Fraser Harbour Commission (NFHC) and Fraser River Harbour Commission (FRHC). This integrated resource planning process, coordinated through DFO and the Harbour Commissions has resulted in the gradual development of an Estuary Management Plan.

DFO, in cooperation with the Fraser River Estuary Management Program (FREMP) has prepared detailed biophysical inventory maps of habitat types in the Fraser River Estuary. The estuary was also divided into 15 Habitat Management Units to facilitate habitat management and planning.

⁴ Like-for-like means that the lost habitat is replaced with the same type of habitat. For example a sedge marsh is replaced with sedge marsh, mudflat with mudflat, and so on.

A habitat management classification system using color codes (red, yellow and green) was added to the inventory maps. Red represents the most productive habitat areas of the estuary. Development in red areas will not be permitted unless it can be shown that no alteration or alienation to the habitat will occur. Habitat compensation sites are included as red coded areas, and are recognized as conservation areas. Yellow represents moderately productive habitats. Development in yellow areas will be permitted subject to satisfactory habitat mitigation and/or compensation. Green represents areas of low productivity. Development in green areas will be permitted subject to environmentally sound design and timing restrictions.

Habitat inventory and color coded maps are an integral part of the Environmental Management Plans of the NFHC and FRHC. Habitat Banking has also been established as part of the Environmental Management Plan. A Habitat Bank is an area of habitat created in the estuary for the purpose of future habitat compensation needs. Habitat may be purchased by a developer from a Habitat Bank in situations where no other compensatory options are available. Habitat Banks have only been developed by the two Harbour Commissions.

Project Review Process

Based on the Fish Habitat Management Policy, DFO is to conduct its project reviews according to the following process:⁵

1. Notification.

Since 1986, the majority of notifications have come to DFO through the FREMP, Coordinated Project Review Process.

2. Examination.

Information is examined by DFO in consultation with other agencies, the proponent and their consultant.

3. Consultation.

Major development projects require public consultation and a thorough review and assessment of all factors.

4. Decision (with provisions to appeal).

A decision is made on whether the project is likely to result in a net loss of habitat. Options are then available to: 1) permit the proposal, 2) request mitigation/compensation, or 3) reject the proposal. An appeal is possible for those habitat-related decision that are in dispute.

⁵ The described project review process is based on the general framework as outlined in the DFO Policy for the Management of Fish Habitat (DFO 1986). This report will show that there have been many variations of the project review process.

5. Audit.

DFO will ensure that compliance monitoring and effectiveness evaluations are undertaken in habitat conservation, restoration and development projects.

6. Enforcement.

As required, DFO will enforce the Fisheries Act for which the DFO Minister is accountable.

ACKNOWLEDGEMENTS

Work on the Habitat Project Database was initiated by DFO's Fraser River Division Habitat Management Unit under the direction of Steve Macfarlane. Subsequent work, including further development of the database, review of habitat projects and preparation of the final report was supported by the Fraser River Action Plan (FRAP) under the federal government's Green Plan. Project direction was provided by Otto Langer, DFO, Fraser River Action Plan. Ron Kistriz assembled the data base, lead the workshops and authored this report.

We are grateful to the following aquatic habitat specialists who participated in the workshops and/or provided information and reviews on the Habitat Project Database and draft reports: Mark Adams, Marissa Byrne, Bruce Clark, Kevin Conlin, Otto Langer, Colin Levings, Steve Macfarlane, Bob McIndoe, Laszlo Retfalvi, René Sauvé, Heather Stalberg and Gary Williams. The North Fraser Harbour Commission and the Fraser River Estuary Management Program office kindly provided boardroom facilities for workshops held in September 1992 and May 1993.

This report was based upon the input of the above individuals and information obtained from Department of Fisheries and Oceans and Fraser Estuary Management Program files. During the study every attempt was made to obtain input from DFO and other agency staff and consultants working in the Fraser Estuary to achieve consensus where possible. Considering the complex nature of determining the no net loss of the productive capacity of a variety of habitats and attempts to include wildlife concerns, opinions and conclusions in this report are not necessarily those of the Department of Fisheries and Oceans.

A digital basemap of the lower Fraser River floodplain area was made available by the Canadian Wildlife Service. This report was formatted for publication by Michael Mascarenhas.

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1.0 INTRODUCTION

1.1 *Purpose of the Study*

This report examines and reviews the application of the Policy on Fish Habitat Management in the Fraser River estuary. Specifically, it focuses on the *No-Net-Loss* (NNL) principle and *Net Gain* objective. The purpose of this study is to determine whether or not we are achieving the NNL principle and Net Gain objective in the Policy on Fish Habitat Management.

The NNL principle is reviewed by examining all of the habitat *compensation* projects that have occurred in the Fraser River estuary since 1983. As explained in the Preface of this report, 1983 was chosen as a starting point because the application of the NNL principle began in that year.

The *Net Gain* objective is reviewed by examining all of the habitat *restoration* and *creation* projects in the estuary since 1983. The objective of these habitat projects was to increase the amount or enhance the quality of habitat in the estuary.

This review is based on the net surface area losses or gains in subtidal, mud/sandflat and marsh habitat, and in the net linear loss or gain of riparian habitat. Habitat losses or gains due to natural accretion or erosion are not included in this review. This review also does not take into account any effects on the productive capacity of habitat due to water quality impacts.

In order to determine the status of NNL in the Fraser River estuary, all habitat projects dealing with compensation, restoration and creation were compiled into a standardized database; the *Habitat Project Database*. Records for all habitat project in the database from 1983 to 1992 are contained in the report's appendix. This database also provides the basis for an audit and retrieval system that can be used for protection and compliance, integrated resource planning, public consultation, information and education, cooperative action, and habitat improvement and monitoring.

A synopsis of the habitat database is provided to offer conclusions on whether there has been an overall net gain or loss in different types of fish habitat over the past ten years. In addition, a project-specific review by a group of aquatic habitat specialists identifies issues and problems related to the implementation of the Fish Habitat Management Policy and recommends opportunities for improvement.

2.0 METHOD

2.1 Database

The Habitat Project Database was originally compiled from the Central Project Registry (CPR) files maintained at the FREMP office. A total of approximately 700 files (1986 to 1992) were reviewed in order to identify those projects that had an associated habitat compensation, restoration or creation component. Information on habitat projects pre-dating the CPR (i.e., <1986) was obtained from agency files such as DFO, MOELP⁶, FRHC, NFHC and environmental consultants.

Information about each habitat project was compiled into database files containing fields for text, numerical and geographical data. Using Superbase Version 2.0⁷, the computer database also includes external image files used to display colour photographs and location maps.

2.2 Maps

Maps in this report were generated from a 1:50,000 scale NTS digital basemap of the lower Fraser River floodplain using QUIKMap Version 2.51.⁸ Maps corresponding to 15 habitat management units (HMU) were created in Transverse Mercator projection.

A unique symbol is used to show the exact location of each habitat compensation, restoration and creation project within each HMU. A dBase file, which is linked to the maps, includes a field for the Universal Transverse Mercator (UTM) geographical coordinates of each site.

2.3 Field Inspections

Habitat Project sites were visited in the summer of 1991 and 1992 to confirm their exact location and configuration, and to identify plant species. Information from CPR and

6 British Columbia Ministry of Environment, Lands and Parks

7 Superbase is a trademark of Superbase Inc. (U.S.), 80 Orville Drive, Bohemia, New York 11716

8 QUIKMap is a trademark of AXYS Software Ltd., P.O. Box 2219, 2045 Mills Road, Sidney, British Columbia. V8L 3S8

agency files was thus verified, and if necessary, revised and appended. On-site colour photographs of each site were used to augment the database.

2.4 Expert Workshops

A workshop was organized in December 1991 to finalize the boundaries of the 15 Habitat Management Units in the estuary. The workshop participants also reviewed a preliminary draft of the Habitat Project Database and helped revise the database structure.

After completion of the Habitat Project Database in 1992, and to augment the file reviews, 23 habitat projects were visited by a group of aquatic habitat specialists on September 23 and 24, 1992. A two day field trip and a one day workshop was organized to assess the successes and failures of each site on the basis of on-site observations and discussions.

A selection of 11 habitat projects were reviewed and analyzed in the workshop. Technical and procedural details of each project were reviewed on the basis of a number of predetermined assessment criteria. Critical issues, problems, and deficiencies identified for each reviewed project were evaluated in order to recommend technical and procedural solutions.

2.5 Data Analysis

In order to examine the application of the NNL policy, habitat data were analyzed for habitat compensation projects. For the Net Gain objective, data were analyzed for habitat restoration and creation projects. Calculations were made to determine the net difference between habitat areas lost and gained. The data were arranged according to the four habitat types: subtidal, sand/mudflat, marsh, and riparian. Results were expressed in square metres with the exception of riparian habitat which was based on linear metres.

Habitat lost by erosion or gained through accretion have not been determined and are therefore not included in this review.

The amount of net habitat was calculated according to specific replacement ratios. The like-for-like habitat replacement ratio (Compensation Habitat:Lost Habitat) was 2:1 for marsh, 1:1 for mud/sandflat and 1:1 for riparian⁹. For example, if 100 m² of lost marsh were effectively replaced with 200 m² of compensation marsh, then the project would have achieved NNL and a net difference of zero would be indicated. For the purpose of this assessment, the NNL calculations were based solely on area. Therefore, area was used as the a proxy for productive capacity and functional equivalency.

Projects which deviated from the specified replacement ratios are described in the footnotes to the data tables. If the net difference is a negative number then habitat compensation was inadequate and the project was unsuccessful. If the net difference is a positive number then the project was not only successful but a net gain of habitat was realized.

Projects where lost mudflat was replaced with compensation marsh were calculated separately with a replacement ratio for marsh gained to mudflat lost of 0.5:1. The achievement of NNL (a zero net difference between losses and gains) for these projects would occur if, for example, 100 m² of lost mudflat were replaced with 50 m² of marsh.

Habitat replacement ratios were not used for subtidal habitat or where mudflat was replaced with habitat other than marsh. For these projects, the amount of net habitat was determined on an individual basis and explained in a footnote.

Habitat compensation associated with the Roberts Bank Coal Port Expansion, B.C. Ferry Terminal-Phase 1 Expansion, Paramount Site, and Brightwater Maritime Village were included in the calculations even though compensation has not yet been completed. These "undetermined" projects have been included in order to fully show the present status of NNL in the Fraser River Estuary. Moreover, some of these projects have been incomplete for many years.

The CN Intermodal Yard Project in Surrey Bend was included because the lost riparian habitat was accessible to fish and the area is included within the FREMP jurisdiction.

⁹ Habitat replacement ratios were published in the Memorandum of Understanding concerning An Environmental Management Plan for the North Fraser Harbour between DFO and the North Fraser Harbour Commission (1988; p12).

3.0 RESULTS AND CONCLUSIONS

3.1 Database Forms

Information about each habitat project (record) is provided on forms in Appendix 1. Table 1 provides a brief explanation of the field headings used on these forms.

3.2 Location Maps

For the purpose of habitat management, the Fraser River estuary was divided into 15 Habitat Management Units (HMU), which are described in Table 2 and shown in Figure 1.

The exact location of each habitat project is shown on maps covering each of the 15 HMUs (Figure 2 to 16). These site maps show whether the habitat project category is compensation (circle), restoration (square) or creation (triangle). Also included on the maps are the HMU boundaries (dashed line) and the western delta front (dotted line). Marshes are depicted as diagonal cross-hatched areas and eelgrass beds as horizontal black areas.

3.3 Net Habitat Lost or Gained

Results of the analysis of net habitat lost or gained are presented in tables arranged on the basis of the four habitat types (Subtidal, Sand/Mudflat, Marsh, Riparian) and three habitat project categories (Compensation, Restoration and Creation). Numbers are sorted in descending order on the basis of the amount of habitat lost with each development project.

Compensation projects are related to the loss or alienation of habitat due to development impacts. For habitat compensation projects, habitat replacement can take place through creation or restoration/enhancement¹⁰. Habitat compensation projects address the NNL Principle of the Policy on Fish Habitat Management. Restoration and Creation projects,

¹⁰ Restoration attempts to bring back habitat production (usually primary production) to its former level. Enhancement attempts to increase the productive capacity of the habitat by manipulating environmental factors such as hydrology (e.g., channelization), and nutrients (e.g. fertilization). Restoration and enhancement effects are usually difficult to separately distinguish without detailed scientific study.

which are usually part of a government initiative, address the Net Gain objective of the Policy.

3.3.1 Subtidal Habitat

Subtidal habitat includes the bottom area below the lowest normal tide level as well as the water volume (column) above the bottom. Shallow subtidal areas, especially adjacent to vegetated shorelines and those supporting eelgrass beds are considered to be important because of their high capacity for benthic production. Subtidal areas associated with deep channels, steep slopes and high water velocities are considered to be of relatively lesser importance. The importance of the water column associated with subtidal habitat depends on the type of use by juvenile and adult fish, especially salmon.

The area of subtidal habitat lost due to development projects is usually indicated in the CPR file, except for the loss or disturbance of subtidal bottom areas due to maintenance dredging. Compensation has not been required for subtidal areas of lesser importance as defined above. However, in situations where important subtidal habitat (as defined above) was lost or if it was sufficiently altered to significantly reduce the overall production normally found in that area, compensation was usually considered.

The replacement of lost subtidal habitat with a similar habitat (i.e., like-for-like) has not been a habitat compensation requirement. Instead, the replacement habitat, if required, has been mud/sandflat or marsh habitat.

Important subtidal areas lost to development projects are listed in Table 3. The total amount of subtidal habitat lost in the past decade due to development projects has been 947,106 m² (Table 3). A substantial part of this loss (94%) occurred on Roberts Bank as a result of the Coal Port Terminal and Tsawwassen Ferry Terminal Expansions.

There is no standard formula for calculating the net loss of subtidal habitat. Explanations for the derivation of the numbers shown in Table 3 are provided in the footnotes to the table.

In the period of 1983 to 1993, the NNL Principle has not been achieved for important subtidal habitat primarily because the loss on Roberts Bank has not yet been fully compensated and some subtidal losses in the river were not compensated (Site 09-001).

3.3.2 Mud/Sandflat Habitat

Mud/sandflat habitat includes the intertidal zone devoid of emergent vegetation, from the lowest normal tide to the lower fringe of marsh growth. This habitat type may include eelgrass beds, benthic algae or submerged aquatic vascular plants. All mud/sandflat habitat is considered to be important because of its benthic invertebrate production.

Table 4 shows that mud/sandflat areas lost to development have been replaced with like habitat at a 1:1 ratio, or by marsh habitat, usually at a ratio of 0.5:1. Some mudflat has also been created as the result of subtidal and riparian habitat losses.

The compensation of mudflat for mudflat has resulting in a net deficit of 20,618 m², primarily due to the large loss associated with the Tsawwassen Ferry Terminal project.

By far the largest number of projects involved the creation of marsh from lost mudflat at a ratio of 0.5:1. For all projects, the difference between mudflat lost and marsh gained has been a net deficit of 4,789 m². This deficit can be attributed to the inadequate or lack of mudflat compensation associated with several projects (e.g., Site #09-001, 03-003, 14-004, 12-003, 09-008, 01-003, 09-007, 11-005, 12-002).

In addition, 22,200 m² of mudflat was created to replace the loss of subtidal and riparian habitat. A significant amount of this mudflat habitat is associated with the Timberland Basin Habitat Bank, which will eventually be converted to marsh used to compensate for lost habitat.

The overall net deficit of 41,020 m² is expected to be reduced as losses associated with the Roberts Bank Coal Port and Tsawwassen Terminal are recovered.

Nevertheless, the NNL principle has presently not been achieved for mud/sandflat habitat primarily because of the undetermined compensation for lost mudflat associated with the Roberts Bank Coal Port.

Table 5 shows the results of habitat creation and restoration projects designed to achieve the Net Gain objective. Habitat creation has resulted in a substantial net loss (66,700 m²) of mud/sandflat areas primarily due to the creation of the large area of terrestrial habitat at the Steveston Jetty, Dredge Spoil Habitat island (Site #06-001). A moderate amount (9,500 m²) of habitat has been regained in the restoration at McDonald Slough and Ladner Lagoon.

3.3.3 Marsh Habitat

Marsh habitat includes the zone of emergent grasses, sedges and forbs that are classified as tidal saltmarsh, brackish marsh and freshwater marsh. This is considered to be the most important feeding and rearing, fish habitat in the estuary.

In like-for-like habitat replacement, the total amount of compensatory marsh area that has been created approximately reflects a 2:1 replacement ratio (Table 6). Additional habitat of 9,703 m² was achieved from compensatory marshes created due to the loss of subtidal, mudflat or riparian habitat. Therefore, with respect to brackish and freshwater tidal marshes, the NNL principle has been achieved.

However the loss of saltmarsh associated with the Tsawwassen Indian Reserve Breakwater creates a net loss for saltmarsh habitat. This project did not have a specific compensation requirement. The amount of potential saltmarsh erosion prevented by the breakwater is thus far undetermined.

Table 7 shows the results of marsh creation and restoration projects undertaken in the last ten years. These efforts have resulted in a net gain of 80,570 m² of marsh habitat.

3.3.4 Riparian Habitat

Riparian habitat includes the linear extent of vegetation on the river floodplain that is flooded only at higher high tides and during river freshet. The vegetation community is characterized by flood tolerant trees and shrubs, or flood tolerant grasses and fobs where woody vegetation does not exist.

Data for projects that required compensation for riparian losses are shown in Table 8. Replacement of lost riparian habitat with like habitat resulted in a shortfall of 1,876 m. In addition, a considerable loss of riparian habitat was also associated with the CN Intermodal Yard project at Surrey Bend.

The NNL principle has not been achieved for riparian habitat. Moreover, the net loss is significantly underestimated because it is a linear rather than an area account.

Habitat restoration and creation efforts have restored and created a total of 2,450 m of riparian habitat.

3.4 Specific Project Reviews

In order to understand why some habitat compensation did or did not achieve NNL, a group of habitat specialists examined a number of specific projects. Table 7 lists and briefly describes the 23 habitat project sites that were visited by the group of aquatic habitat specialists. The table also includes a rating for the success or failure of a project to meet the NNL principle.

The success or failure of a project in meeting the NNL Principle was expressed on a four point scale as follows:

NNL Achieved

- | | |
|--------------------------|--|
| (S) Successful | - Habitat was fully compensated |
| (P) Partially Successful | - Habitat was only partially compensated |

NNL Not Achieved

- | | |
|-------------|--------------------------------------|
| (L) Loss | - There was a net loss of habitat |
| (F) Failure | - The project was a complete failure |

3.4.1 Assessment Criteria

To assist with the evaluation of each habitat project during the workshop, a number of assessment criteria were identified under three major headings; a) physical, b) biological and c) procedural. The list of assessment criteria, which were posted on a flip chart, helped focus and standardize the habitat project evaluations. The assessment criteria were as follows:

a) Physical

1. Surface **Elevation**.
2. **Substrate** characteristics of bedding material.
3. **Exposure** to waves and currents.
4. **Drainage** characteristics of surface runoff and seepage.
5. **Salinity** of flood water.
6. **Light** conditions (exposure to sunlight).
7. Problems related to wood **Debris**.

b) Biological

1. Types of **Plant Species**.
2. **Production**, standing crop and distribution of growth.
3. **Fish** access, especially juvenile salmon.
4. **Herbivory** associated with grazing geese or other wildlife.
5. **Invertebrate** types and production.

c) Procedural

1. Existing **Management Plan** or evaluation procedure.
2. Site inspections and **Assessments**.
3. **Feasibility** assessment of conceptual design.
4. Sources and derivation of **Design** criteria.
5. **Construction** details and procedures.
6. **Compliance**, supervision and post-construction inspections.
7. Post-project biophysical **Monitoring**.
8. **Remediation** of project failures.

9. **Tenure**, security of the site and long-term responsibility.

Not all of the above assessment criteria pertained to each habitat project. Therefore, only the most relevant criteria were discussed in any detail for each project evaluation.

3.4.2 Evaluations and Opportunities for Improvement

There was insufficient time during the workshop to evaluate all of the 23 projects that were visited in the field. The workshop participants therefore selected a short-list of 11 projects to evaluate.

Each project was introduced and described by a workshop participant most familiar with its features and past history. A brief summary of this narrative is provided for each project description that follows. Additional details about each project are available on the Habitat Project Database forms provided in Appendix 1.

Each project evaluation was based on an open discussion that was structured around the assessment criteria previously described. Problems, relevant issues and the strengths and weaknesses of each project were discussed. Any significant issues pertaining to the success or failure of a particular project were listed on a flip chart for further discussion.

Site# 01-001

Restoration

Schenker Distribution, North Arm Fraser River, Burnaby

In 1985 this shoreline area was being restored as part of a general waterfront redevelopment project from heavy industry to warehousing. There was no actual habitat loss and therefore no habitat compensation was required. However, as part of the riverbank revetment work, DFO suggested the use of large open paving stones as an alternative material to the traditional rip-rap material.

Physical

The elevation of the paving stones was based on surface elevations of adjacent marsh vegetation. A sand bed was placed underneath the stones without any filter fabric or other erosion protection structures. There was no engineering design prepared for the site which was prepared on the basis of the manufacturer's instructions. Eventually the bedding material washed out, the stones shifted and became dislodged.

Biological

It was expected that natural colonization would fill the spaces in the paving stones with marsh vegetation. However, this was not the case. With much of the substrate washed away, the amount of plant growth after 8 years is very sparse.

Procedural

Design of the habitat enhancement work was based on the manufacturer's information for the paving stones. The project was supervised by DFO personnel who also made several site visits after construction. A concrete toe berm was put in place to alleviate the movement of paving stones down the intertidal bank. No further follow-up has been undertaken.

Evaluation

This project was judged to be a failure since no habitat was created or restored.

Opportunities for Improvement

Even the simplest project requires a minimum of engineering input to address physical site conditions and project design.

Construction should have been better supervised so that adjustments could have been made during placement of the stones.

There should have been greater accountability on the part of the proponent and DFO to allow for remediation and follow-up work. Although the habitat is no worse than what was there previously, the experiment to use paving stones in this manner was not successful.

Site# 03-001

Restoration

Fraser River Park, North Arm, Vancouver

This river shoreline, which was a former Vancouver City dump site, has been cleaned up and restored to bring back a more natural aquatic habitat. The existing fill was pulled back from the toe of the existing foreslope to create an intertidal area and a slough. The slough opening was armored with rip rap and flows were controlled by a weir. Marsh vegetation (*Carex lyngbyei* and *Juncus balticus*) was transplanted to the intertidal area from Iona Island. The slough banks were planted with *Typha latifolia* and *Iris pseudocorus*. The project was a joint effort between DFO and the Vancouver Parks Department. The vegetation was monitored by a consultant for one year and visually inspected by DFO for several years after transplanting. This site is one of the sites where plants, fish and invertebrates are being studied (1991-93) by Colin Levings as part of a FRAP, Green Plan initiative. Vegetation re-planting and the installation of a wing dam have been undertaken as measures to remediate problems associated with sand movement and erosion.

Physical

The existing surface elevation is higher than what was originally constructed because berms, which were caused by wave action from passing boats have been formed from the

predominantly sandy substrate. The action of wave scour in combination with the sand dominated surface materials have resulted in an unstable substrate. A portion of the sedge vegetation planted in the intertidal zone has been washed away at lower elevations or smothered by sand accretion at higher elevations. The shear boom designed to deflect log debris from the site is not working since it requires annual maintenance but the responsibility was not assigned to any particular group. The slough is retaining water at low tide according to its design.

Biological

Plant species adapted to the newly created higher elevations, and sandy soils have invaded the site. Other lower intertidal areas support sedges and rushes. The slough supports a dense community of submerged aquatic plants (possibly *Myriophyllum* spp.). The area was designed to provide good access to fish and also support bird habitat. After initial transplanting there was a problem associated with grazing geese. Recent monitoring work (pers. comm. Dr. Levings) has shown that fish access to the site is less than what was measured at a nearby reference site.

Procedural

This habitat restoration project was successfully handled in terms of site assessment, conceptual design, design criteria, engineering, construction and follow-up. The site was monitored very closely, and as a result, two re-transplants, several debris clean-up efforts, and the installation of a shear boom were undertaken. The upland portion of the site is being maintained by the Vancouver Parks Board. However, responsibility for maintaining a functional shear boom has not been resolved. Many of the erosion and accretion problems could have been averted by letting the site stabilize for one year prior to transplanting.

Evaluation

This project was judged to be successful because the original shoreline was restored and new habitat created.

Opportunities for Improvement

The use of unprotected sand fill should be avoided in restoration projects of river shoreline areas subject to wave induced scour.

Shear booms are relatively ineffective when grounded on sites where strong river currents and wave action prevail. This is especially the case where shear booms come to rest on rip-rap structures. An engineering assessment is required to determine whether this type of shear boom can work.

Site# 03-002

Compensation

Richmond Island, North Arm, Vancouver

The intertidal embayment constructed at the downstream end of Richmond Island compensated for a subtidal area filled to create a log storage yard at the Eburne Saw Mill. To create the embayment, approximately 20,000 m³ of waste fill was removed from the end of the island. The 8,106 m² subtidal area lost was replaced with a 4,053 m² marsh area. The conceptual design was based on surveys of existing marsh elevations in Eburne Slough. A protective berm was constructed partially around the site. Transplants, mainly *Carex lyngbyei* were taken from Iona Island.

Physical

The site was slightly overexcavated resulting in elevations too low to support *Carex*. The site was overdredged in anticipation of natural infilling. The site is well protected from wave scour and appears to support a stable substrate of fine grained materials and organic matter.

Biological

Marsh vegetation is limited to higher areas along the inner fringe of the embayment. The site is dominated by a large mudflat which supports invertebrates and fish (sampled by Colin Levings) and shore birds. The site is also frequented by Canada Geese which created a grazing problem immediately after transplanting.

Procedural

There was no post-construction survey undertaken to check elevations and make adjustments where necessary. Plans for planting riparian vegetation along the protective berm were not implemented. Nor was there any monitoring work undertaken. The lack of progress and follow-up was due to the change in management staff at Eburne Saw Mill resulting in several years of delay in addressing existing problems at the site. There was also inadequate follow-up by agency staff.

Evaluation

This project was considered to be moderately successful because a large waste dump was converted into an intertidal area; however, full marsh growth was not achieved.

Opportunities for Improvement

Construction of the compensation site must be supervised by a biologist and engineer to ensure that design specifications are being properly followed.

Biophysical conditions of compensation sites must be monitored for several years after construction. An evaluation of remedial actions is required by the regulatory agencies.

A more consistent and effective follow-up process must be undertaken for projects where management staff are replaced. The review procedure needs an effective "bring forward" filing system that will ensure follow-up review and remedial action is necessary.

Site# 04-001

Compensation

Deering Island, North Arm, Vancouver

This project compensated for the unvegetated intertidal flats (2,284 m²) affected by the creation of the compensation marsh. The intertidal flats filled by the developer were predominantly mudflat, while the intertidal flat used to site the compensation marsh was predominantly a mixture of construction debris (i.e. brick and concrete fragments),

gravel, sand and mud. Vegetation monitoring was undertaken in September 1991 (observations) and September 1992 (sampling). Preliminary results indicate that marsh creation has been successful in the establishment of a sedge marsh, dominated by Lyngby's sedge and softstem bulrush.

Physical

Although the site was constructed with a rip-rap perimeter with a shear boom on top, it inadequately protected against large waves from passing boats and wood debris. The installed shear boom is not working properly. The existing rock berm should have been built higher with fish access openings as an alternative to the boom (up to 3 m), but this option was rejected due to cost considerations.

Biological

Biological monitoring is being undertaken (Envirowest) and through a Green Plan initiative (Colin Levings). Some natural colonization by *Scirpus validus* has been noted. Riparian vegetation planted along the top of the existing dyke is being damaged by people, horses and vehicles. The top of the dyke may also be too dry to support the types of vegetation planted.

Procedural

Proper input from agencies such as CWS was missing in the determination of what should have replaced the riparian habitat lost in Celtic Slough. Ultimately, DFO accepted the replacement of riparian habitat with compensation marsh. The existing sterile foreshore (concrete blocks) now surrounding Deering Island is an example of the lack of creative environmental design. The question of the long-term responsibility of maintaining the compensation site remains unresolved.

Evaluation

This project was considered to be successful.

Opportunities for Improvement

The structure and function of shear booms designed to protect habitat compensation sites need to be completely reviewed.

A more serious attempt must be made to incorporate biological considerations into engineering designs of shoreline structures.

The loss of productive riparian habitat needs to be more thoroughly assessed in determining the type of compensation required.

Site# 05-001

Compensation

Miller Road Pump Station, Middle Arm, Richmond

The small (40 m²) marsh bench created on the west bank of Morey Channel was in compensation for the loss of sedge marsh growing on a riprap bank. The bank was reconstructed for the installation of a drainage outfall. The compensation site was built two years after the shoreline habitat was lost.

Physical

The City of Richmond undertook all of the construction work. Substrate elevation was initially too high and riprap had to be redone due to a failure along the upper end of the compensation site. The substrate consists of relatively mobile sand and there has been some plug erosion.

Biological

No biological monitoring is being undertaken. Habitat compensation was deferred by the City of Richmond for approximately two years before any action was taken.

Procedural

There was no supervision during the construction phase and limited post-construction monitoring.

Evaluation

- This project was considered to be successful.

Opportunities for Improvement

- Construction supervision and post- construction monitoring is required even for small compensation projects.
- Compensation must be undertaken before or at the time of habitat loss.
- Habitat banking areas should be used to compensate for small losses at isolated sites or the impacts accumulated and concentrated at a more viable location..

Site# 07-002

Compensation

B.C. Ferry Terminal, Phase 1 Expansion

Habitat compensation was required for the Phase 1 expansion project (Mid Island Terminal). Although the project was in a red-coded area, an exception was made by DFO for approval based on the consideration that this was a project of significant public interest. The first habitat compensation plan to fill a large area of mudflat and create a saltmarsh was rejected. In the meantime, DFO and B.C. Environment management staff looking after the file were replaced by different staff. The plans that were resubmitted for second review had not been substantially redesigned. Furthermore, the environmental consultant working for B.C. Ferry Corporation did not identify the presence of eelgrass beds in the site that was to be filled for the habitat compensation project. As time passed, considerable pressure was placed on agency staff to facilitate a quick approval. Conditional approval was granted through the OIC 908 process, further complicating the approval process. The significant impact of the project on existing eelgrass beds was not

resolved prior to construction proceeding. The planned compensation works also did not take into account the loss of additional valuable habitat.

Physical

A gravel berm was built and filled with dredged sand to create a compensation platform on the existing mudflat. A dense, smooth crust developed on the surface of the compensation site. The site was subjected to considerable erosion in the first winter.

Biological

A very small pilot transplanting effort using *Salicornia virginica* was undertaken with limited success. The intertidal basin did not seem suitable for marsh transplants. Eelgrass was also transplanted, although information on the quantity and method of planting did not appear to be available. Therefore, compensation for the loss of the natural eelgrass bed by the construction of the ferry terminal remains undetermined. The creation of the compensation site further increased the habitat losses.

Procedural

There was a breakdown of communication and cooperation between agencies, the proponent and the consultant. There did not appear to be any agreed upon environmental review process, nor was there any compliance to existing agreements. There was no enforcement of existing legislation or authority. The OIC 908 process did more to confuse than to help the environmental review process. B.C. Ferries pressured the agencies to rush through the project review process without proper consideration of approvals.

Evaluation

To date, this project is considered to be a failure; however, plans are underway to correct existing problems so as to ultimately provide proper habitat compensation.

Opportunities for Improvement

Environmental assessments and compensation designs need to be closely scrutinized by the environmental agencies.

If a major deficiency is identified, the process of approvals and above all the project (fill) must not be allowed to continue.

This project has resulted in significant loss of estuarine habitat. A significant and creative compensation project will be required to recover these losses.

Site# 09-002

Compensation

Garry Point, South Arm, Richmond

Construction of rock groins and beaches along Garry Point by the City of Richmond covered almost 10 ha of intertidal mud and sandflat supporting patches of marsh. To compensate for this, three small pocket marshes were created in the area known as the "Hole in the Wall". There was significant difficulty in obtaining the compensation and it was built well after the habitat was lost.

Physical

In the two inland pocket marshes, the rock berm constructed to serve as protection against waves and wood debris proved to be effective. However, in the smaller marsh, the rock berm was not high enough and significant current scour had affected almost 25% of the transplanted plugs.

Biological

Other than visual observations, there is no monitoring of the site. The larger shelf marsh located in the most protected area seems to be in the best condition.

Procedural

Below the high water line, a 20 year lease to the Provincial Crown is administered by the Fraser River Harbour Commission.

Evaluation

This project was considered to be successful.

Opportunities for Improvement

The middle pocket marsh could be improved.

Earlier cooperation by the City of Richmond to built compensation works as part of the park could have led to a more productive and cost-effective design.

Site# 10-002

Compensation

National Metal, South Arm, Richmond

The proposed compensation project was originally rejected by DFO due to its location in a red-coded area. Compensation was required to replace habitat lost on the north shore of the South Arm in Richmond at Triangle Road. Requests to revise the project design in order to avoid sensitive habitat were evaded by the proponent. After several appeals and considerable lobby pressure by the proponent, the compensation marsh was built a considerable distance from the area of impact. Not only was the restricted definition of red-coded habitat violated, but agency staff had to find off-site compensation, which was another deviation from the accepted hierarchy of preference in the Fish Habitat Management Policy.

Physical

The mean surface elevation of the compensation bench is higher than the original site.

Biological

The site is being monitored by Colin Levings under the FRAP Green Plan.

Procedural

There was a significant deviation away from the normal FREMP environmental assessment and review process due to appeals by the proponent and the involvement of the highest levels within DFO.

Evaluation

Although the marsh transplant was successful, the overall project was considered to be a only partially successful because the compensation site was well removed from the impact site and located in an area of abundant marsh. The compensation site was also built smaller than what was specified.

Opportunity for Improvements

This project demonstrates how valuable habitat can be lost adjacent to a development area. Half of the site, which was high quality habitat (red-coded) lost its protected status through a series of appeals. The habitat was replaced on the other side of the South Arm in a GVRD park. The park area has no shortage of good quality habitat contrary to the area of impact.

In order to prevent a proponent from bypassing certain procedures, there must be a commitment by the agencies to allow the FREMP process to arrive at its own final decision. Since this project created significant procedural problems, the FREMP foreshore classification and review mechanism has since been better defined.

In situations where the normal environmental review process fails or is not properly applied, the process must be subjected to external examination by an impartial adjudicator or environmental ombudsman.

Site# 11-001

Compensation

Patrick Island, Annacis Channel, Delta

To compensate for the loss of fringe marsh due to construction of the Pembina Street swing bridge, an embayment was created at Patrick Island. Productive riparian forest was lost in order to create a subtidal embayment. A fringe marsh was planted around the intertidal margin of the embayment.

Physical

The embayment was designed to retain approximately 2 m of water at low tide. A 1:5 side slope was required to create such a deep basin. This resulted in slope failures, slumping and erosion. Stormwater runoff from the adjacent highway was directed into the embayment creating deep gullies. A shear boom installed across the opening of the embayment is working effectively to deflect wood debris; however, yearly maintenance is required.

Biological

The slope was too steep to support marsh vegetation and much of the original transplanted plugs were lost due to erosion. A fringe marsh has developed over time through natural colonization. A dense Alder forest has developed above the high water line. Fish monitoring studies two years after construction showed that juvenile salmon were present in the embayment.

Procedural

The final habitat design did not adequately compensate for habitat lost. Riparian forest was replaced with subtidal habitat. Recommendations to maximize aquatic plant production by creating a shallower, more intertidal basin were rejected by the proponent (Ministry of Highways and Transportation) and DFO in favor of maximizing subtidal habitat.

Evaluation

This project was considered to be moderately successful.

Opportunities for Improvement

Productive riparian forest communities should not be sacrificed to create habitat compensation sites. Further habitat remediation work should not be undertaken since the site now has a naturally developing riparian and marsh community.

Site# 11-008

Compensation

West Patrick Island Development, Annacis Channel, Delta

A roughly 30 ha area consisting of actively flooded swamp, floodplain forest, sloughs and lagoons on Patrick Island (Annacis Island) was filled in 1985 for industrial development. Roughly 12 ha of this area was identified as being directly or indirectly accessible to fish. To compensate for the loss of this fish habitat, the fill and development was set back 30 m from the shoreline. A tidal channel was excavated parallel to the shoreline within this protected habitat area. Ultimately, for each ha of wetland lost, only 0.25 ha of wetland was protected and/or replaced.

Physical

The channel has access to flows from the Fraser River through 5 outlets along its length. Each section of channel was designed with the lowest elevations at each of the outlets to provide complete drainage. Riparian vegetation was retained, forming island type complexes.

Biological

Plant recolonization was monitored by DFO in the first two years. Transplanting was not undertaken but root and top soil material was back-graded on the slopes during construction resulting in very rapid recolonization. Fish food production was not monitored.

Procedural

Initial filling and deforestation of Patrick Island in the 1970s proceeded without any restrictions or habitat compensation imposed by the government agencies on Grosvenor International. Most of the natural slough separating Patrick from Annacis Island was filled without restriction. Grosvenor International had acquired tenure of the slough from the federal government in 1960.

Evaluation

This project was considered to be successful.

Opportunities for Improvement

There was nothing in place to replace the floodplain forest habitat that was lost; only accessible fish habitat was considered.

Site# 13-002

Compensation

Timberland Basin, Main Arm, Surrey

Timberland basin, a former log pond, was converted into a future habitat compensation area (i.e., a habitat bank) in anticipation to adjacent port development. The habitat area, which was created with dredged material will have sufficient area for habitat compensation in addition to that required for the planned Timberland port development.

Physical

The area was built behind an existing training wall. It was graded to provide a gentle slope and material was added to the site to reach an elevation suitable for marsh growth.

Biological

The trial planting in 1992 was only partially successful due to heavy grazing pressure from Canada geese. The area is undergoing rapid succession to a low marsh community

by extensive natural colonization. Past clearing by navigation authorities of riparian vegetation growing on the training wall was questioned.

Procedural

The need for transplanting should be reassessed in view of the success of natural colonization.

Evaluation

This project was considered to be a success; however, the purpose of the site is for habitat banking. The habitat created at the site will eventually be used to compensate for habitat lost to development projects in that area.

Opportunities for Improvement

Transplanting in areas subject to intensive grazing by geese should be reconsidered. Additional fish access channels are required to increase fish utilization of the area.

4.0 Issues and Recommendations

4.1 Approval Framework

If the agencies involved in the Estuary Management Plan allow for the removal and replacement of red-coded habitat, then the Plan is weakened. When a decision is made to allow the loss of habitat and new habitat is to be built as compensation habitat, a much more rigorous process of approval, construction and monitoring is required. Above all, habitat in red-coded areas must not be lost.

4.2 Inspection and Accountability

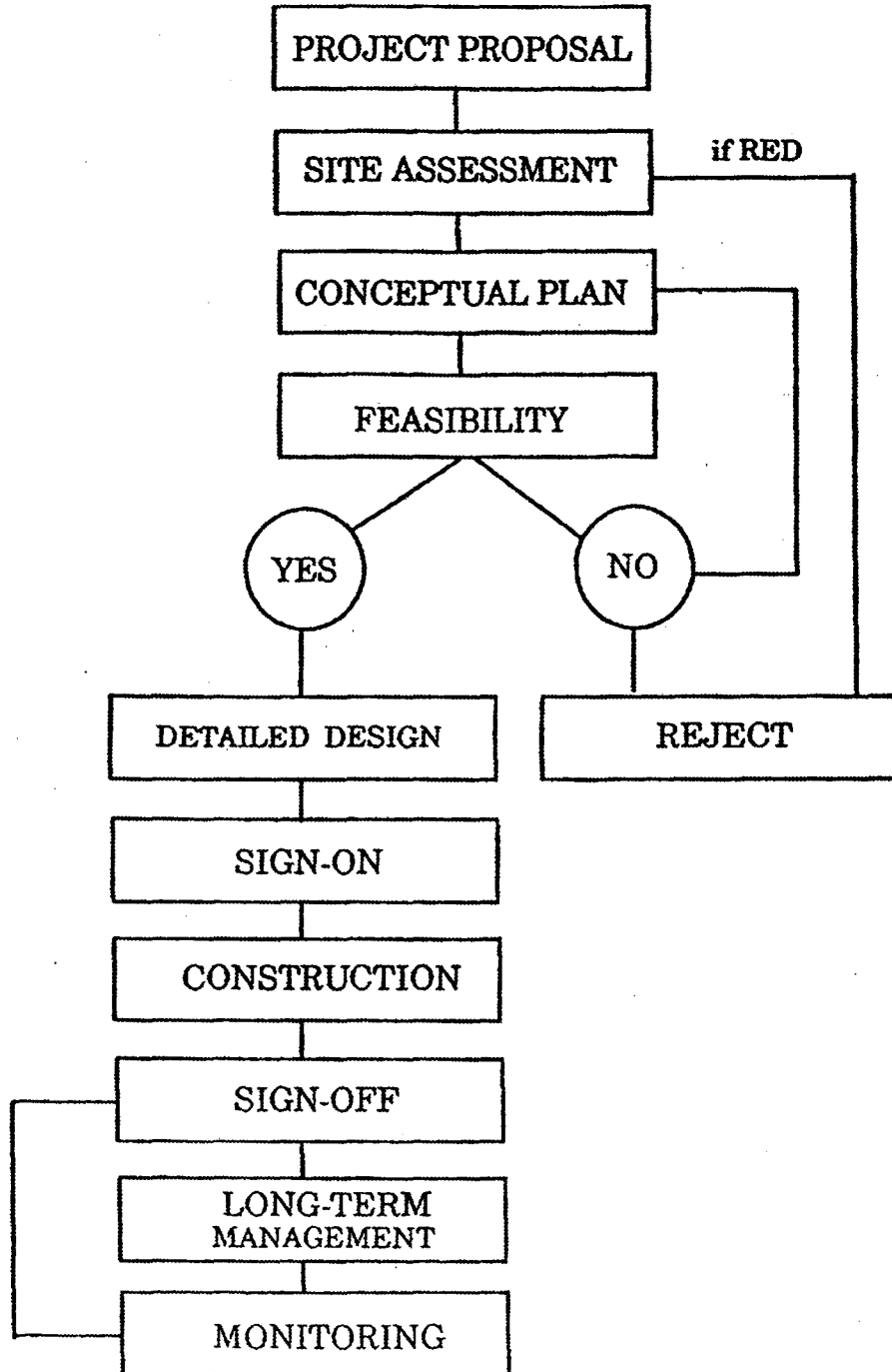
A common weakness associated with many habitat projects is the lack of conformity between what was originally designed and intended and what is actually completed. The weak links in the referral process were attributed to the lack of proper site inspections, approvals of work completed and overall project accountability. This is in large part due to the inability of agency staff to follow-up and monitor.

Site conditions and construction designs need to be closely inspected by a biologist, engineer and the approval agency. If the site conditions or conceptual habitat compensation designs are not feasible, then deficiencies must be identified, described and rectified. The project proposal may also be rejected at this stage.

Proper accountability can only be assured with a consenting agreement between the proponent, consultant and the approval agencies. A signing-on agreement is required before work starts to clarify what everyone is agreeing to (e.g. habitat losses, compensation ratios, project design, monitoring, tenure and long-term responsibilities). A signing-off agreement is required to ensure that all terms and conditions have been satisfactorily met. The signed agreements should be a legal contract or, as a minimum, a letters of agreement. A copy of the currently drafted Generic Habitat Compensation Agreement is provided in Appendix 2.

The following flow chart illustrates the process described above:

Project Delivery Procedure



4.3 Update of Habitat Inventory Maps

It was recommended at the last FREMP Habitat Workshop (June 27-28, 1990) that the Habitat Inventory and Colour-Coded maps which were produced in 1988 must be updated approximately every five years. These maps need to be updated to include the location of habitat compensation projects and other physiographic changes. Habitat project sites should have a proper geographical reference and be entered into a spatial database. Regular updating should be undertaken by a central agency such as FREMP or DFO.

4.4 Habitat Protection and Security

The long-term security and protection of both natural and man-made habitats is presently not assured. Only a small percentage of habitat in the Fraser River Estuary is properly secured in Wildlife Management Areas or National Wildlife Areas. Most of the valuable habitat is protected through agreements (red-yellow-green coding) between DFO and the FRHC and NFHC. However, these agreements are essentially based on good-will, and are therefore not protected against future changes in the commitment to effectively protect habitat. Our project-specific reviews identified several instances where habitats were lost and questionable habitat compensation projects were a result of staff changes and appeals (by the proponent) to higher levels of authority.

Several options for securing valuable habitat must be pursued such as special municipal zoning, land purchases, land transfers from crown provincial, restrictive covenants, and tax incentives. In the meanwhile, habitat that is coded red and yellow must be protected more effectively.

4.5 Debris Barriers and Source Control

Many of the debris barriers installed to protect habitat projects are not functioning properly (e.g. Deering Island, Fraser River Park, Fraser Richmond Landfill). The failure of these protective structures needs to be analyzed and remedied. New design and installation guidelines need to be developed and made available. The question of the responsibility of the long-term maintenance of debris barriers needs to be addressed.

A related and more fundamental issue is the needless release of large amounts of mill or construction related debris into the river and the lack of an effective source control program downstream of Agassiz. Recommendations on the control of log debris made by the FREMP Log Handling Committee need to be implemented. It is counterproductive to clean up marsh areas and install debris protection works when the source of the problem remains.

4.6 Type of Habitat Replacement

In some habitat projects, the habitat that was lost or alienated was replaced with a different type of habitat (so called "like for unlike"; e.g. Patrick Island), or in a different location ("off-site compensation"; e.g. National Metal). The present NNL Guiding Principle follow a hierarchy of preferences which allows for the negotiation of a "like-for-unlike" habitat replacement option if the preferred "like-for-like" option is considered difficult to undertake. This type of habitat replacement should be a last resort only where it is biologically defensible.

Also, DFO has favored the development of marsh habitat replacement regardless of the habitat type lost. This emphasis on marsh compensation, restoration and creation needs to be more closely examined.

There must be a stricter assessment and consultation process in cases where one type of habitat is proposed to be replaced with another type or in an off-site location. Factors that limit the quantity and quality of habitat lost must be examined on a site-specific and regional basis (i.e. within each Habitat Management Unit). Lost habitat should be replaced within a Habitat Management Unit (HMU). However, trade-offs between HMUs (e.g., Site# 10-002, National Metal) requires further scrutiny and guidelines.

4.7 Request for Monitoring

Monitoring of habitat projects has not been a standardized procedure, nor has it been consistently applied. A basic and standard protocol involving a step by step assessment and set time frame should be developed for physical and biological monitoring. Post-construction monitoring should be a standard requirement for all habitat projects. There

must also be pre-project assessment of the lost or alienated habitat and the selected habitat compensation site.

A monetary bond should be in place to ensure that failures or deficiencies identified by the monitoring program can be dealt with in a timely and effective manner. The bond should be a realistic value based upon the replacement cost of the marsh or some other identifiable high risk.

4.8 Minimum Size

Some very small-sized habitat projects have been undertaken – such as the one at the Miller Road Pump Station (70 m²). It is not known how a small-sized compensation habitat functions in the estuary. It was the general opinion of the workshop participants that the cost of constructing small individual habitats less than ca. 50 m² would be less cost-effective than accumulating the compensation in a habitat bank. Alternatively, small habitat losses could be accumulated and a larger compensation site built.

4.9 Continuity of Decision Making Process

The review and decision making process of some habitat projects (e.g. Site# 07-002, B.C. Ferry Terminal) has been problematical due to the assertiveness of the proponent, the transfer of files between agency staff or the involvement of different levels of government. This can result in different approaches taken to reviews of similar projects over time, and a poorly informed decision making process. This has led to probably the most significant loss of habitat in the estuary during the past decade. Compensation must now be pursued after-the-fact. Should a NNL balance not be clarified before habitat compensation work begins, the project must not be approved. Further, any project located in a red zone must be more closely scrutinized. In the B.C. Ferry Terminal case, the consultants and agency staff did not know that the approved dredge and fill compensation site was located on an existing eelgrass bed.

Agencies must have continuity of knowledgeable technical staff that follow consistent guidelines of technically based and well defined procedures. A review process that is open to public scrutiny would further ensure consistency and continuity.

4.10 Remediation

In some sites (e.g. Site# 03-002, Richmond Island) it is apparent that even after several years, habitat compensation has not, and probably will not meet its intended goal. Two options are available:

- a) If the site has developed into a functional habitat, then it may be best not to remediate and to allow the site to undergo its natural process of seral succession.
- b) If the habitat is clearly short on compensation, then on-site or off-site remediation measures should be undertaken.

These remediation strategies must be clearly tied into the biophysical monitoring program. The remediation/monitoring program must address the biological as well as the physical well-being of the site. The Habitat Compensation Agreement must specify that biological remediation must extend 3-10 years and physical remediation 5-20 years depending on the risk involved. Certain remediation works such as shear booms may require an indefinite maintenance clause attached to them. This clause should be tied into the property deed to circumvent problems with changes in property ownership.

4.11 Natural Recolonization vs Transplanting

In pre-built habitat projects or habitat banking, there may be the option of allowing natural colonization to take place. For most habitat compensation sites, transplanting is a prerequisite in order to accelerate the starting phase of plant colonization. The exception may be in cases where a donor site is unavailable or expected to be heavily damaged. Natural colonization would be an acceptable method if the compensation area is pre-built at least two to four years before any project-related habitat losses occur.

There is a need for more scientific study of controlled transplanting and natural colonization experiments.

4.12 Habitat Compensation Research

The improvement of habitat policies and guidelines is closely connected to the information from habitat compensation research. However, in spite of the ten year history of habitat creation efforts in the Fraser River Estuary, there is almost no local scientific data on the functional aspects of created versus natural wetland habitat.

Numerous opportunities to acquire large amounts of biophysical data have been lost because of the lack of pre and post project monitoring. A more rigorous monitoring strategy including work on fish utilization and fish food organisms should be built into the monitoring requirements of all larger projects.

Lack of funding is a chronic problem impeding the progress in habitat research. Since government agencies have limited research funds, the following alternative funding sources should be explored.

For larger habitat projects, the proponent could be required to participate in habitat research related to the project site. A small levy (application fee, etc.) could be charged on larger habitat projects in contribution to a habitat research fund. Habitat research should be undertaken as coordinated efforts among several agencies.

The FREMP Habitat Sub-Committee of the Water and Land Use Committee should organize Habitat Workshops (cf. FREMP 1990) on an annual basis to address information updates, research needs and new directions in habitat guidelines and policy. The review of habitat research proposals and administration of projects could be undertaken by a "Fraser Estuary Foundation" similar to the B.C. Conservation Foundation.

4.13 Impact on Donor Sites

The guidelines and inspection of the approach used to borrow transplant material from donor sites have to date been somewhat vague and inconsistent.

Habitat Agreements must include specific instructions on donor site locations and the procedures used to borrow materials and mitigate impacts. It is important to emphasize the utilization of salvaged plant material and original surface soils from the development

site. If necessary, salvaged materials should be stockpiled in designated areas for future use.

4.14 Habitat Banking

Habitat banking is defined as an agreed upon mechanism or process where habitat is developed for the purpose of providing compensation for future commercial or industrial development projects. The advantage of habitat banking include ensuring that viable habitat is created prior to losses from development. This would also reduce the need for small-scale and less cost-effective habitat compensation that generally have a limited structural and functional role in the estuary.

Habitat banking has to date not yet been fully tried and tested. Banked habitat must only be used to replace a like habitat lost elsewhere. DFO has agreed that if the banked habitat is proven by DFO and FREMP to be viable, then a replacement ratio of 1:1 (lost:banked) would be considered. There is some concern that habitat compensation available prior to a development may weaken the priority of establishing habitat conservation, protection and mitigation as a first option in development projects.

4.15 NNL-Net Gain Habitat Accounting

Effective and ongoing records must be maintained of all habitat losses and gains in the Fraser River estuary. Better guidelines must be developed to equate trade-offs (e.g., where marsh is built to replace riparian habitat).

As previously indicated, this review calculated NNL on the basis of area only. However, a much more rigorous habitat accounting system must be developed. Compensation projects should be monitored for a standard period of time (e.g. 3 to 5 years) and compared to a natural or control site. This comparison should be based on some measure of production.

The ledger of accounting should be based on the level of production at the end of the monitoring period. For example, after a 2:1 replacement of marsh habitat, if the compensation marsh achieved less than a 50% production level then NNL would not have

been achieved. If 50% production were achieved, NNL would have been achieved. If the site had greater than 50% production, then a Net Gain would have been achieved.

TABLES

TABLE 1. Explanation of field headings used on the Habitat Database Project forms.

Field Heading	Explanation
SITE NO.	A unique number that identifies each site location; the first two digits of the number identify the HMU.
C.P.R. NO.	A unique number used to locate the project in the FREMP, Central Project Registry file.
CATEGORY	The category of habitat activity which can be Compensation, Restoration or Creation. Compensation involves the replacement of habitat lost or damaged due to a FREMP approved development activity. Restoration involves the treatment or clean-up of habitat that has been altered or degraded, usually by some historical human activity. Creation involves the construction of new habitat on a site where that habitat does not presently exist.
STATUS	A project is Complete if all terms of the agreement understood about the habitat work have been finalized. The project is Incomplete if one or more aspects of the habitat agreement remain incomplete.
IMPACT DATE	The date when the habitat was lost or degraded.
CONSTR. DATE	The date when the habitat project was built.
PLANT DATE	The date when transplanting occurred.
PROJECT NAME	The name that the project is best known as; this usually refers to the name of the development project.
PROPONENT	The name of the project proponent.
LOCATION	A brief description of the habitat project location.

TABLE 1. Explanation of field headings used on the Habitat Database Project forms.

Field Heading	Explanation
UTM GRID REF.	The Universal Transverse Mercator grid reference. The grid zone designation (10U) is the same for the entire study area. The two, six digit UTM numbers give a geographical reference to the nearest metre. The number is given as Easting followed by Northing.
IMPACT	This is a description of the impact that caused the loss or degradation of habitat.
RATIONALE	Need of development project and description of the quantity and quality of habitat compensation, restoration or creation that was accepted in the final plan.
FEATURES	This is a description of the physical features of the habitat project
HABITAT BALANCE SHEET	The habitat balance sheet provides the areas of habitat lost, gained and the net amount remaining. The four habitat types (subtidal, mud/sandflat, marsh and riparian) correspond to the habitat types shown in the FREMP applications.
LAST ON-SITE INSPECTION	The date of the last on-site inspection for the purpose of this study.
MONITORING PERIOD	The span of year that biophysical monitoring was undertaken at the site. If no monitoring was undertaken or requested then it is indicated as "NIL."
REQUIREMENT FOR REMEDIAL ACTION	Remedial action is indicated (as YES) if inadequacies identified at the site require immediate attention. A further description of the problem and the remediation work required is described in the ADDITIONAL COMMENTS field.

TABLE 1. Explanation of field headings used on the Habitat Database Project forms.

Field Heading	Explanation
WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED?	This YES or NO answer is based on the opinion of the group of habitat experts that participated in this study. This report provides further explanations on the rationale for deciding whether a project was considered to be successful or not.
VEGETATION GROWING ON-SITE	Dominant and associated plant species that were identified to be growing in the project site are listed in two separate fields.
DOCUMENTATION & CONTACTS	Publications, reports and other documents relevant to the project are listed; along with the names of DFO personnel and consultants directly involved in the project. This is not a complete listing ! Some projects have many more references than those indicated.
ADDITIONAL COMMENTS	This field contains information that expands on or does not apply to the other existing fields in the form.

TABLE 2. Description of the Habitat Management Unit (HMU) boundaries

HMU#	Description
01	<p>NORTH ARM: Poplar Island to Boundary Road The upstream boundary corresponds to the railway trestle that crosses the North Arm from the west end of Lulu Island to New Westminster near Poplar Island. The downstream boundary corresponds to a line extending across the river from the foot of Boundary Road, which is also the Vancouver-Burnaby boundary.</p>
02	<p>NORTH ARM: Boundary Road to Arthur Laing Bridge The downstream boundary of this reach is the Arthur Laing bridge.</p>
03	<p>NORTH ARM: Arthur Laing Bridge to McDonald Slough The downstream boundary of this reach corresponds to a line that crosses the river from the foot of Balaclava Street in Vancouver to Sea Island across the entrance of McDonald Slough.</p>
04	<p>NORTH ARM: McDonald Slough to Point Grey The downstream boundary of this reach corresponds to the outer boundary of the North Fraser Harbour Commission (NFHC). This boundary connects the end of the north Arm Jetty with the tip of Point Grey.</p>
05	<p>MIDDLE ARM: Bridgeport to Swishwash Island The upstream boundary corresponds to a line across the upper end of the Middle Arm from the east end of Sea Island (NFHC office) to Bridgeport. The downstream boundary corresponds to a line from the northwest corner of Lulu Island (Terra Nova) to the southwest corner of Sea Island.</p>
06	<p>STURGEON BANK This area includes all of Sturgeon Bank. The eastern boundaries correspond to the downstream boundaries of UNIT 04 and 05. The western boundary to the outer FREMP boundary, which is the western delta front. The northern limit is the end of Point Grey Peninsula. The southern limit is Steveston Jetty.</p>
07	<p>ROBERTS BANK This area includes Roberts Bank and Canoe Pass. The eastern boundary corresponds to the downstream boundary of UNIT 09. The western boundary corresponds to the outer FREMP boundary, which is the western delta front. The southern limit is the international border.</p>

TABLE 2. Description of the Habitat Management Unit (HMU) boundaries

HMU#	Description
08	<p>BOUNDARY BAY This area includes all of Boundary Bay, Mud Bay and Semiahmoo Bay. The southern boundary is the international border.</p>
09	<p>SOUTH ARM: Steveston to Deas Island The downstream boundary corresponds to the outer harbour limit of the Fraser River Harbour Commission (FRHC). This harbour limit corresponds to a line from Garry Point (Lulu Island) to the west end of Albion Island and from Westham Island to Brunswick Point. The upstream boundary parallels the George Massey Tunnel, goes up the length of Deas Island to the end of Deas Slough.</p>
10	<p>SOUTH ARM: Deas Island to Annacis Island The upstream boundary of this reach corresponds to the power line crossing at the southern tip of Annacis Island.</p>
11	<p>SOUTH ARM: Annacis Channel This unit includes all of Annacis Channel from the downstream power line crossing to a line from the upper end of Annacis Island across to the end of Lulu Island.</p>
12	<p>SOUTH ARM: City Reach and Annieville Channel The downstream boundary corresponds to the power line crossing at the downstream end of Annacis Island. The upstream boundary corresponds to a line from the tip of Annacis Island to the end of the first training wall on the other side of the river.</p>
13	<p>MAIN ARM: Annacis Island to Port Mann Bridge The downstream boundary of this reach includes the upstream boundaries of UNIT 01, 11 and 12. The upstream boundary corresponds to the Port Mann bridge.</p>
14	<p>MAIN ARM: Port Mann Bridge to Kanaka Creek The upstream boundary of this reach corresponds to the upper limit of the FREMP jurisdiction which ends at Kanaka Creek. The boundary across the end of the Pitt River is described for UNIT 15.</p>
15	<p>PITT RIVER The downstream boundary is a line from the foot of Pitt River Road (Port Coquitlam) across to Pitt Meadows where Dyke Road veers sharply to the southeast. The upstream boundary is a straight line across Pitt Lake from the B.C. Forest Products boat launch.</p>

TABLE 3. Balance Sheet for Subtidal Habitat associated with Compensation *.

SITE	PROJECT NAME	LOST	GAINED	NET	Note
	Subtidal for Subtidal @ 0:1				
07-002	Roberts Bank Coal Port/Container Terminal	850,000	0	-850,000	17
07-003	Tsawwassen Terminal - Phase 1 Expansion	42,500	0	-42,500	18
12-004	Alex Fraser Bridge, South Sand Island	20,000	0	0	19
13-002	Timberland Basin	16,000	0	0	20
09-001	National Metal Compensation Site, Deas Slough.	10,500	0	-10,500	21
03-002	CANFOR Site, end of Richmond Island.	8,106	0	0	22
11-001	Patrick Is. Habitat Compensation	0	16,000	0	23
	Total	947,106	16,000	-903,000	

* In most cases compensation for loss of subtidal habitats was not required.

17. Roberts Bank, shallow subtidal including eelgrass beds; has thus far not been replaced; therefore a net deficit is shown. Habitat losses occurred prior to 1983, and this project has been included to fully show the present status of NNL in the Fraser River estuary.
18. Roberts Bank, shallow subtidal (excluding eelgrass beds) was not compensated; therefore a net deficit is shown.
19. Shallow subtidal, brackish-freshwater, replaced with marsh and mudflat
20. Shallow subtidal, freshwater, replaced with mudflat which is intended for habitat banking and will eventually be converted to marsh.
21. Shallow subtidal, freshwater; has not been compensated; therefore a net deficit is shown.
22. Shallow subtidal, freshwater; has been replaced with mudflat and marsh.
23. Riparian habitat (floodplain forest) was replaced with a subtidal embayment and intertidal mudflat and marsh. This is not considered a net gain because of the much greater value associated with the loss of the floodplain forest.

Table 4. Balance Sheet for Mud/Sandflat Habitat associated with Compensation.

SITE	TYPE OF COMPENSATION & PROJECT NAME	LOST	LOST	GAINED	GAINED	NET	NOTE
	Mudflat for Mudflat @ 1:1	Mudflat	Other	Mudflat	Marsh		
07-003	Tsawwassen Terminal - Phase 1 Expansion	70,000		48,600		-22,000	24
02-001	Bridgepoint Market Compensation Site, Mitchell Is.	27,000		27,000		0	25
11-004	Grosvenor Habitat Park, S. End of Annacis Is.	3,500		5,016		1,516	26
10-003	Unwood Homes Ltd., Compensation Site.	300		120		-180	27
09-005	River Road & Admiral Blvd. Compensation Site.	54		100		46	28
	Subtotal	100,854		80,836		-20,618	
	Marsh for Mudflat @ 0.5:1						
09-001	National Metal Compensation Site, Deas Slough.	8,500			0	-8,500	29
03-003	CANFOR Site, North Shore Of Eburne Slough.	4,325			0	-4,325	30
04-001	Deering Island Compensation Site.	3,944			1,972	0	31
13-001	Westminster Quay, Phase 1, Compensation.	3,150			192	0	32
14-004	Miller Contracting, Compensation, Parsons Channel.	2,500			1,000	-500	33
05-002	No. 2 Road Bridge.	1,675			838	1	34
12-003	Burlington Northern RR, Gunderson Slough.	1,450			172	-1,106	35
09-008	Erosion Protection Wall, Ladner Yacht Club.	1,047			0	-1,047	36
02-002	Richmond Plywood Compensation Site.	530			635	740	37
01-003	Westminster Quay Phase 2, Compensation Site.	501			108	-285	38
13-003	Port Mann Log Sort, Compensation Site.	501			627	753	39
14-001	C N Railway, Twin Tracking, West Surrey Bend.	500			4,000	7,500	40
12-004	Alex Fraser Bridge, South Sand Island	350			1,450	2,550	41
09-007	Paramount Site, Cannery Channel.	250			0	-250	42
11-005	Storm Sewer Outfall #11, Annacis Channel.	240			0	-240	43
12-002	Vito's Compensation Site.	80			0	-80	44
	Subtotal	29,543			10,994	-4,789	
	Mudflat from Other Habitat Types						
03-002	CANFOR Site, end of Richmond Island	0	Subtidal	4,000		4,000	45
11-001	Patrick Is. Habitat Compensation	0	Riparian	2,200		2,200	46
13-002	Timberland Basin	0	Subtidal	16,000		16,000	47
	Subtotal	0		22,200		22,200	
	Undetermined						
07-002	Roberts Bank Coal Port/Container Terminal	30,000	0	0		-30,000	48
14-003	Marine Way Industries, Port Hammond	7,813	0	0		-7,813	49
		37,813	0	0		-37,813	
	Overall Compensation						
	Total	168,210		103,036		-41,020	

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24. inadequate compensation; net deficit of 22,000 sq.m. of what was originally dendritic outflow channels; however, the 48,600 sq.m. area of the created mudflat will be planted with marsh vegetation in order to adequately compensate for the original habitat losses..
 25. adequate compensation
 26. adequate compensation with a net gain of 1,516 sq.m.
 27. inadequate compensation; net deficit of 180 sq.m.
 28. adequate compensation with a net gain of 46 sq.m.
 29. no compensation; net deficit of 8,500 sq.m.
 30. no compensation; net deficit of 4,325 sq.m.
 31. adequate compensation
 32. net deficit should be 2,766 sq.m. based on 0.5:1 replacement ratio; however, approval was given for a replacement ratio of 0.06:1.
 33. inadequate compensation; net deficit of 500 sq.m.
 34. adequate compensation
 35. inadequate compensation; net deficit of 1,106 sq.m.
 36. no compensation; net deficit of 1,047 sq.m.
 37. adequate compensation
 38. inadequate compensation; net deficit of 285 sq.m.
 39. adequate compensation
 40. adequate compensation; however, details of this project are unclear
 41. adequate compensation
 42. no compensation; net deficit 250 sq.m.; this project is yet to be completed
 43. no compensation; net deficit 240 sq.m.
 44. no compensation; net deficit 80 sq.m.
 45. a subtidal loss of 8,106 sq.m (Table 3) was replaced with mudflat and marsh (Table 6)
 46. a large area of floodplain forest was converted into subtidal (Table 3), mudflat and marsh (Table 6)
 47. a subtidal area (Table 3) was converted into a mudflat for the purpose of habitat banking
 48. no compensation for brackish-saline intertidal flats
 49. no compensation

TABLE 5. Habitat Balance Sheet for Mud/Sandflat associated with Restoration and Creation (Net Gain objective)

SITE	PROJECT NAME	LOST	GAINED	NET
	Habitat Creation			
06-001	Dredge Spoil Habitat Creation, Steveston Jetty	100,000	20,000	-80,000
03-001	Fraser River Park	0	10,000	10,000
11-009	Annacis Auto Terminal	0	1,800	1,800
09-009	Marina Gardens - Stormwater Treatment System	0	1,500	1,500
	Subtotal	100,000	33,300	-66,700
	Habitat Restoration			
01-001	Schenker Warehouse	0	0	0
04-002	Dentritic Channel Enhancement	0	2,000	2,000
08-001	Boundary Bay Log Removal Project	0	0	0
09-003	Ladner Lagoon	0	7,500	7,500
09-006	Clean Marsh and Estuary Project	0	0	0
10-001	Tilbury Slough Restoration Project	0	0	0
11-006	Shoreline Clean-up, Annacis Island	0	0	0
	Subtotal	0	9,500	9,500
	Total	100,000	42,800	-57,200

TABLE 6. Habitat Balance Sheet for Marsh Habitat associated with Compensation.

SITE	TYPE OF COMPENSATION & PROJECT NAME	LOST		GAINED	NET	Note
		Marsh	Other			
	Marsh for Marsh @ 2:1					
02-001	Bridgepoint Market Compensation Site, Mitchell Is.	7,700		15,400	0	
10-002	Fraser Richmond Landfill, Compensation Site.	5,000		10,000	0	
09-001	National Metal Compensation Site, Deas Slough.	2,400		3,100	-1,700	
05-002	No. 2 Road Bridge.	1,325		3,662	1,012	
09-002	Garry Point Park	840		1,680	0	
09-007	Paramount Site, Cannery Channel.	750		488	-1,012	
04-001	Deering Island Compensation Site.	1,325		3,662	1,012	
12-001	Gunderson Slough Habitat Bench	625		625	0	50
03-003	CANFOR Site, North Shore Of Eburne Slough.	575		625	-525	
12-004	Alex Fraser Bridge, South Sand Island	275		550	0	
12-003	Burlington Northern RR, Gunderson Slough.	164		500	172	
09-008	Erosion Protection Wall, Ladner Yacht Club.	143		0	-286	
09-004	Riverwest Condominiums, Ladner.	100		410	210	
01-002	Olofson & Hewitt Compensation Site.	60		0	-120	
09-005	River Road & Admiral Blvd. Compensation Site.	54		250	142	
10-003	Linwood Homes Ltd., Compensation Site.	50		180	80	
05-001	Miller Road Pump Station	20		70	30	
	Subtotal	21,406		41,202	-985	
	Marsh from Other Habitat Types					
03-002	CANFOR Site, end of Richmond Island.		Subtidal	53	53	
11-001	Patrick Is. Habitat Compensation		Riparian	2,150	2,150	
11-004	Grosvenor Habitat Park, S. End of Annacis Is.		Mudflat	7,500	7,500	
	Subtotal			9,703	9,703	
	Undetermined					
07-001	Tsawwassen Indian Reserve Breakwater	30,000		0	-30,000	51
11-002	Brightwater Maritime Village	0		1,866	1,866	52
	Subtotal	30,000		1,866	-28,134	
	Overall Compensation					
		51,406		52,771	-19,416	

50. this project was accepted at a 1:1 replacement ratio
51. the lost habitat is saltmarsh; an undetermined amount of saltmarsh may have been protected by the breakwater.
52. this tidal marsh area has been pre-built in anticipation of the loss of 2,198 sq.m. of mudflat and marsh

TABLE 7. Habitat Balance Sheet for Marsh Habitat associated with Restoration and Creation (Net Gain objective).

SITE	PROJECT NAME	LOST	GAINED	NET
	Habitat Creation			
03-001	Fraser River Park	0	15,000	15,000
11-009	Annacis Auto Terminal	0	600	600
09-009	Marina Garden's - Stormwater Treatment System	11,750	11,920	170
	Subtotal	11,750	27,520	15,770
	Habitat Restoration			
04-002	Dentrific Channel Enhancement	2,200	0	-2,200
08-001	Boundary Bay Log Removal Project	0	17,000	17,000
09-003	Ladner Lagoon	0	50,000	50,000
11-006	Shoreline Clean-up, Annacis Island	10,500	10,500	0
	Subtotal	12,700	77,500	64,800
	Total	24,450	105,020	80,570

TABLE 8. Habitat Balance Sheet for Riparian Habitat associated with Compensation.

SITE	TYPE OF COMPENSATION & PROJECT NAME	LOST	GAINED	NET	Note
	Riparian:Riparian @ 2:1				53
10-002	Fraser Richmond Landfill, Compensation Site.	665	0	-665	
04-001	Deering Island Compensation Site.	486	105	-381	
09-001	National Metal Compensation Site, Deas Slough.	300	0	-300	
11-007	Titan Construction, Compensation, Annacis Channel.	270	270	0	
12-004	Alex Fraser Bridge, South Sand Island	250	0	-250	
14-006	S & R Compensation Site, Barnston Island.	161	161	0	
11-001	Patrick Is. Habitat Compensation	120	120	0	
02-001	Bridgepoint Market Compensation Site, Mitchell Is.	100	0	-100	
09-007	Paramount Site, Cannery Channel.	100	0	-100	
14-001	C N Railway, Twin Tracking, West Surrey Bend.	100	0	-100	
09-005	River Road & Admiral Blvd. Compensation Site.	35	80	45	
13-002	Timberland Basin	25	0	-25	
	Subtotal	2,612	736	-1,876	
	Undetermined				
14-002	C N Intermodal Yard, Surrey Bend.	718	0	-718	54
	Total	3,330	736	-2,594	

53. the numbers in this table are linear metres and therefore do not represent the true extent of riparian habitat.

54. this number is based on the perimeter of a 35,250 sq.m. block of riparian habitat located on a natural floodplain of the estuary.

TABLE 9. Habitat Balance Sheet for Riparian Habitat associated with Restoration and Creation (Net Gain objective).

SITE	PROJECT NAME	LOST	GAINED	NET
	Habitat Creation			
03-001	Fraser River Park	100	500	400
09-009	Marina Garden's - Stormwater Treatment System	0	650	650
	Subtotal	100	1,150	1,050
	Habitat Restoration			
04-002	Dentrific Channel Enhancement	0	200	200
09-003	Ladner Lagoon	0	1,200	1,200
	Subtotal	0	1,400	1,400
	Total	100	2,550	2,450

TABLE 10. List of Habitat Project sites visited and evaluated

Site #	Site Visit	Detailed Evaluation	Level of Success	Habitat Mgmt. Area Number	Project Name	Location
				North Arm		
01-001	✓	✓	F	1	Schenker Warehouse	8335 Meadow, Bby
03-001	✓	✓	S	3	Fraser River Park	Foot of Angus Rd., Vancouver
03-002	✓	✓	P	3	Richmond Island	Eburne Saw Mill
03-003	✓	✓	L	3	Eburne Slough	Eburne Saw Mill
04-001	✓	✓	S	4	Deering Island	Foot of Carrington St., Vancouver
				Middle Arm		
05-002	✓		S	5	No.2 Rd. Bridge	River Road, Richmond
05-001	✓	✓	S	5	Miller Rd. Pump	Moray Channel Bridge
				Roberts Bank		
07-003	✓	✓	F(*)	7	B.C. Ferry Terminal	Tsawwassen
				South Arm		
09-001	✓		P	9	Fraser Rmd. Landfill	West of Nelson Rd., Richmond
09-002	✓	✓	S	9	Garry Point	Steveston
09-003	✓		S	9	Ladner Lagoon	Ladner
09-004	✓		S	9	Riverwest Condos	47A St., Ladner
09-005	✓		P	9	Marina Estates	Admiral Blvd.
09-009	✓		P	9	Marina Estates	West of Ferry Road
10-002	✓	✓	P	10	National Metal	Deas Slough
12-004	✓		S	12	Alex Fraser Bridge	River Road, North Delta
				Annacis Island		
11-001	✓	✓	P	11	Patrick Island	Annacis Channel Crossing
11-002	✓		L	11	Brightwater	Foot of Carter St.,
11-004	✓		S	11	Grosvenor Park	West Annacis Island
11-008	✓	✓	S	11	Streamside Channel	North-central Annacis Island
				Main Arm		
13-001	✓		S	13	The Quay, Phabse I	Westminster Quay
13-003	✓		S	13	The Quay, Phase II	Old Columbia Str.
13-002	✓	✓	NA	13	Timberland	Tannery Rd.

Level of Success

S = Successful

L = Loss

F(*) = Compensation Incomplete

P = Partially Successful

F = Failure

NA = Not Applicable

... for an explanation of the rating scale, refer to text.

FIGURES

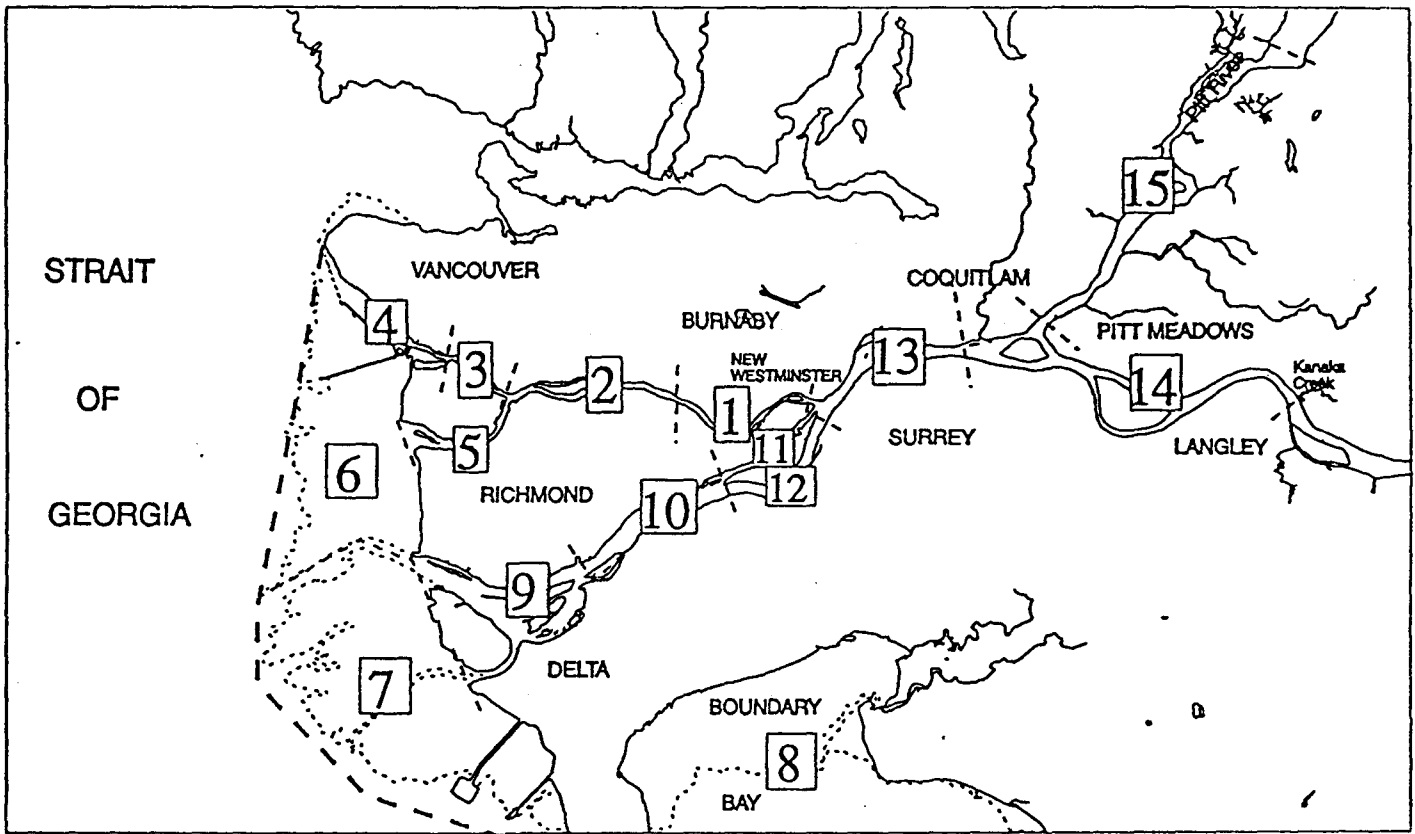


FIGURE 1. Map of Fraser River Estuary (FREMP Area) showing boundaries (dashed line) and location of the 15 Habitat Management Units (HMU).

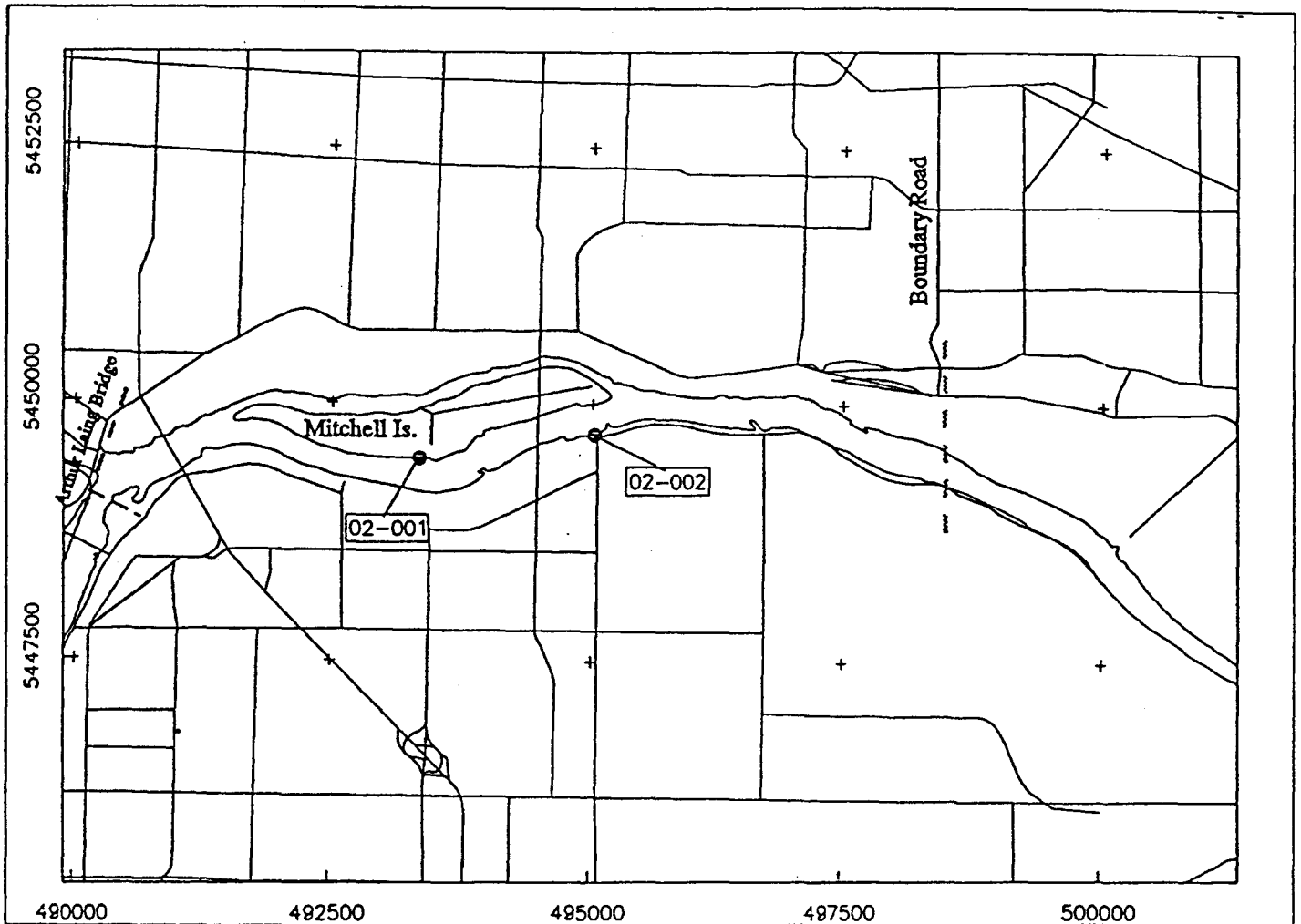


FIGURE 3. HMU 02: NORTH ARM, Boundary Road to Arthur Laing Bridge

Dashed lines represent the HMU boundaries. Dotted lines correspond to the western delta front. Cross-hatched areas are marsh or other wetland types. Black areas are eelgrass beds. Symbols labeled with a boxed number are Habitat Project sites representing compensation (circle), restoration (square) and creation (triangle).

The following habitat projects are included on this map:

<u>Site No.</u>	<u>Project Name</u>	<u>Category</u>
02-001	Bridgeport Market Compensation Site, Mitchell Is.	Compensation
02-002	Richmond Plywood Compensation Site.	Compensation

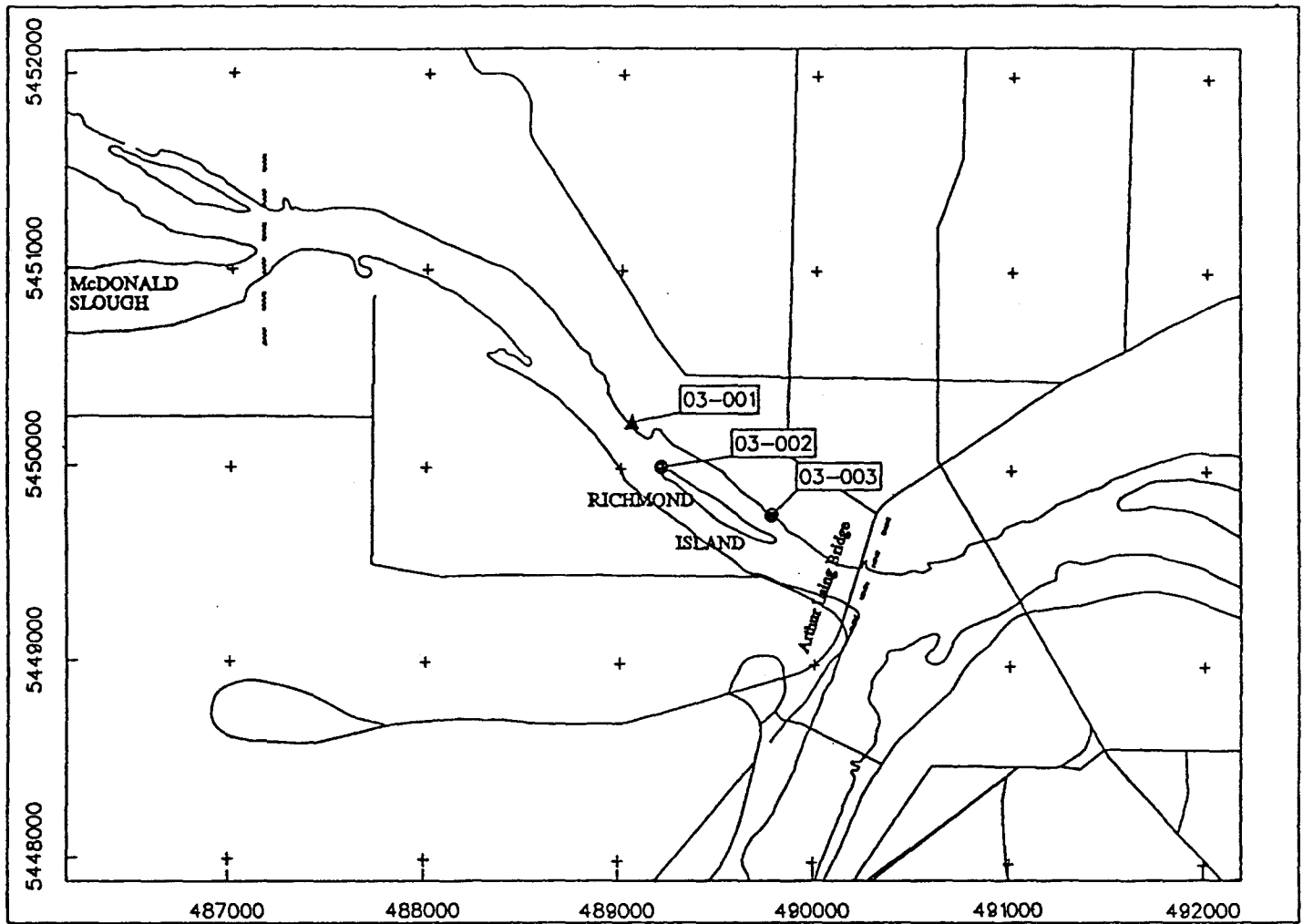


FIGURE 4. HMU 03: NORTH ARM, Arthur Laing Bridge to McDonald Slough

Dashed lines represent the HMU boundaries. Dotted lines correspond to the western delta front. Cross-hatched areas are marsh or other wetland types. Black areas are eelgrass beds. Symbols labeled with a boxed number are Habitat Project sites representing compensation (circle), restoration (square) and creation (triangle).

The following habitat projects are included on this map:

<u>Site No.</u>	<u>Project Name</u>	<u>Category</u>
03-001	Fraser River Park	Creation
03-002	CANFOR Site, end of Richmond Island.	Compensation
03-003	CANFOR Site, North Shore of Eburne Slough.	Compensation

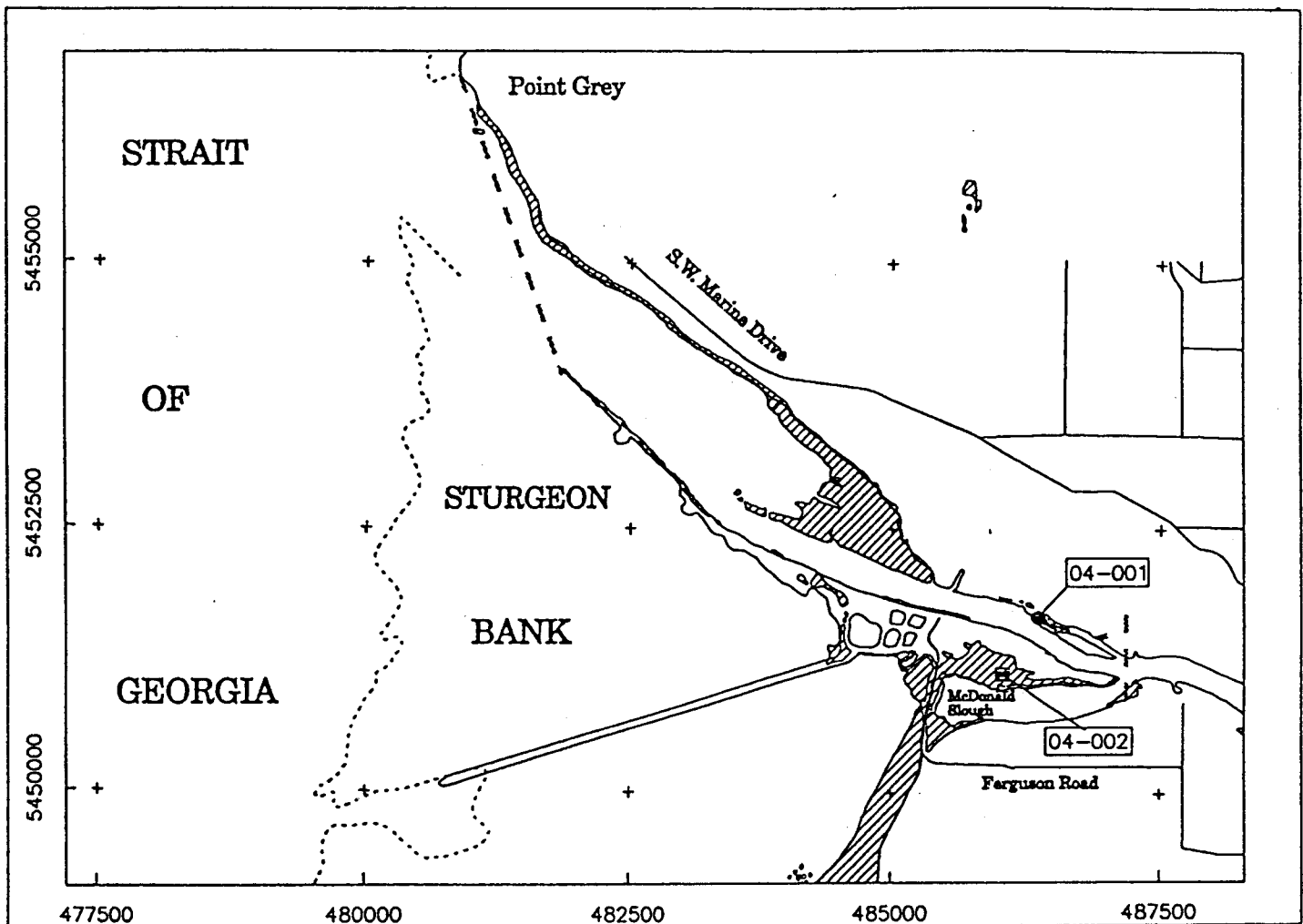


FIGURE 5. HMU 04: NORTH ARM, McDonald Slough to Point Grey

Dashed lines represent the HMU boundaries. Dotted lines correspond to the western delta front. Cross-hatched areas are marsh or other wetland types. Black areas are eelgrass beds. Symbols labeled with a boxed number are Habitat Project sites representing compensation (circle), restoration (square) and creation (triangle).

The following habitat projects are included on this map:

<u>Site No.</u>	<u>Project Name</u>	<u>Category</u>
04-001	Deering Island Compensation Site.	Compensation
04-002	S.E.P., MacDonal Slough Restoration Site.	Restoration

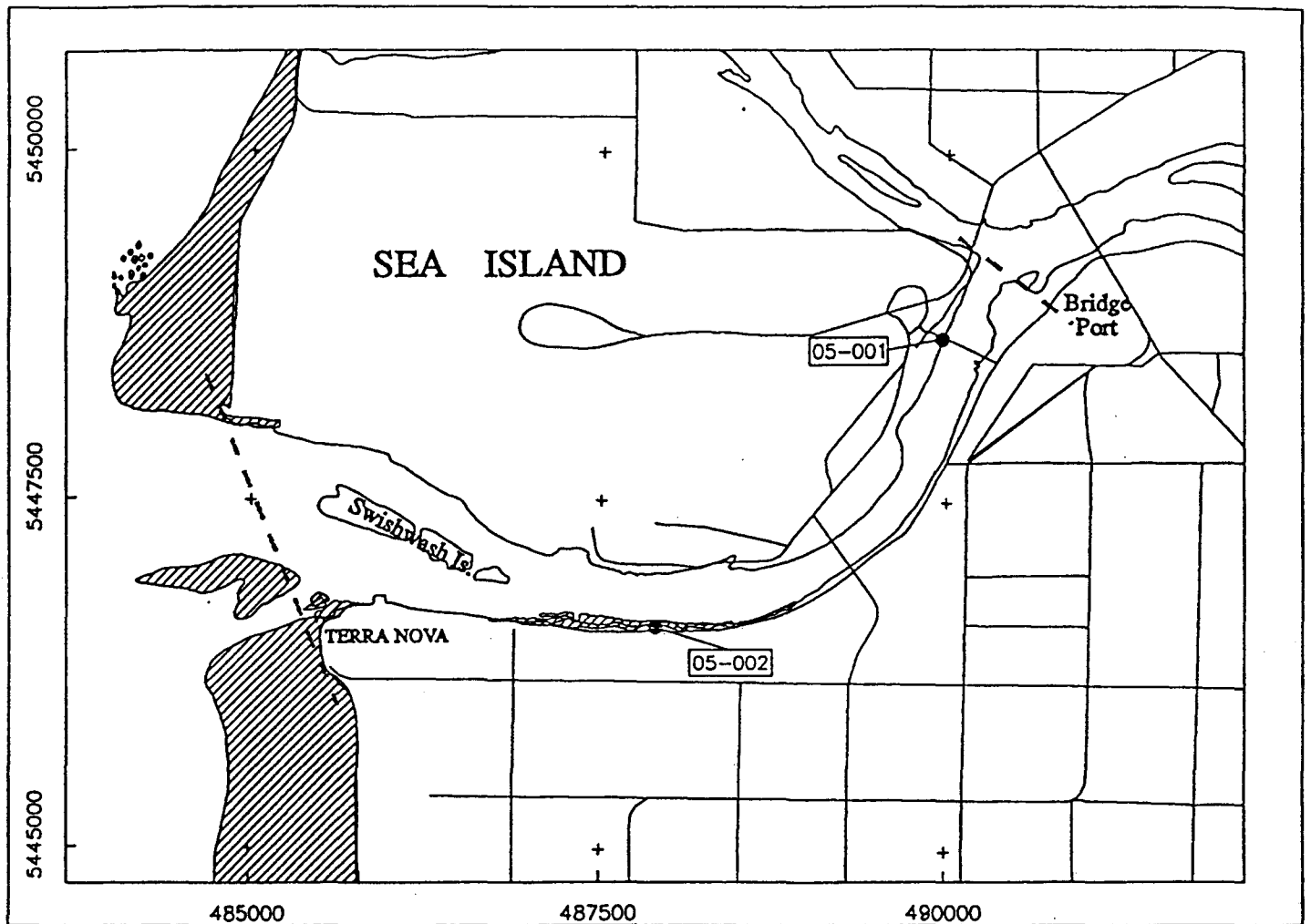


FIGURE 6. HMU 05: MIDDLE ARM, Bridgeport to Swishwash Island

Dashed lines represent the HMU boundaries. Dotted lines correspond to the western delta front. Cross-hatched areas are marsh or other wetland types. Black areas are eelgrass beds. Symbols labeled with a boxed number are Habitat Project sites representing compensation (circle), restoration (square) and creation (triangle).

The following habitat projects are included on this map:

Site No.	Project Name	Category
05-001	Miller Road Pump Station	Compensation
05-002	No. 2 Road Bridge.	Compensation

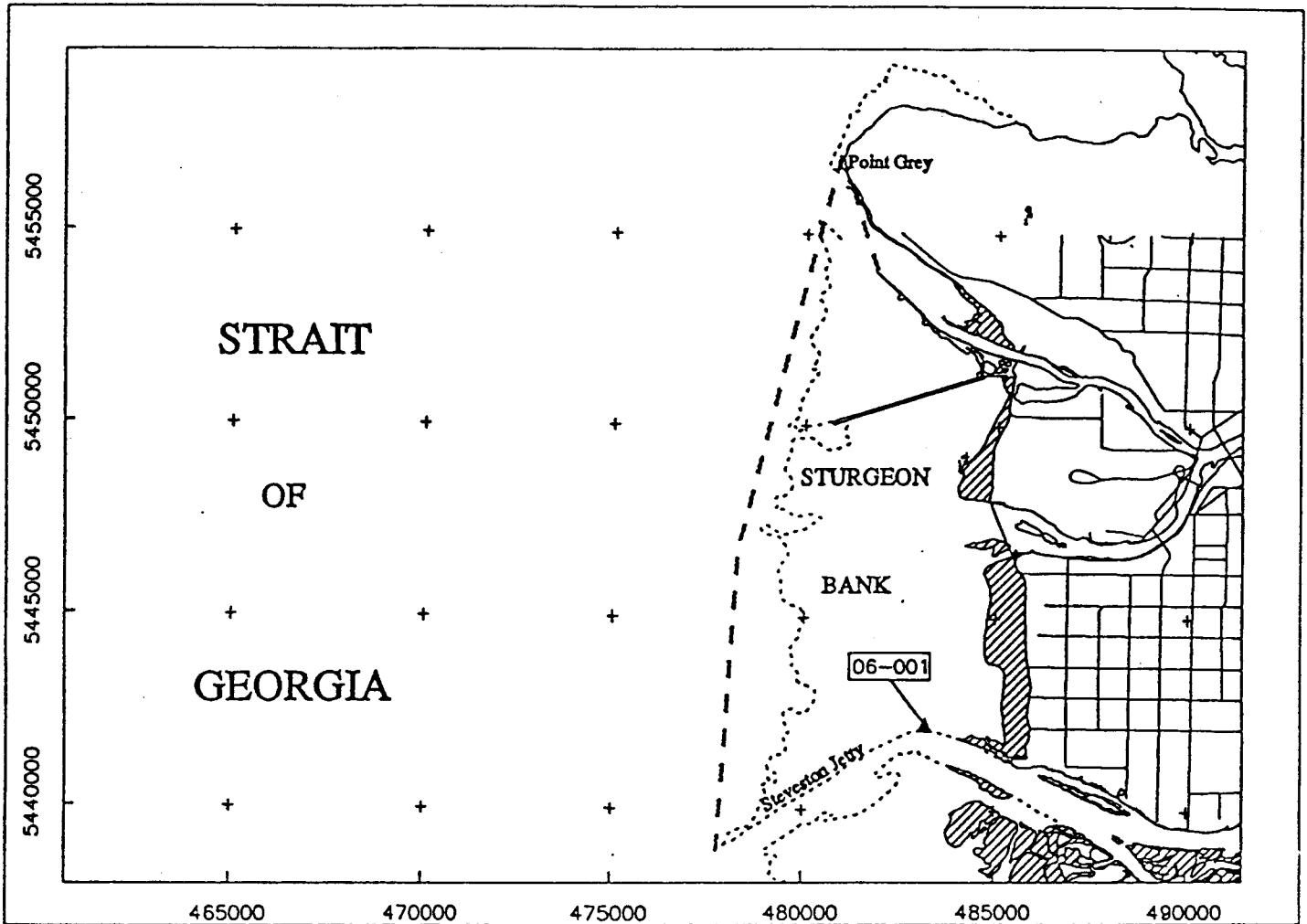


FIGURE 7. HMU 06: STURGEON BANK

Dashed lines represent the HMU boundaries. Dotted lines correspond to the western delta front. Cross-hatched areas are marsh or other wetland types. Black areas are eelgrass beds. Symbols labeled with a boxed number are Habitat Project sites representing compensation (circle), restoration (square) and creation (triangle).

The following habitat projects are included on this map:

<u>Site No.</u>	<u>Project Name</u>	<u>Category</u>
06-001	Dredge Spoil Habitat Creation, Steveston Jetty.	Creation

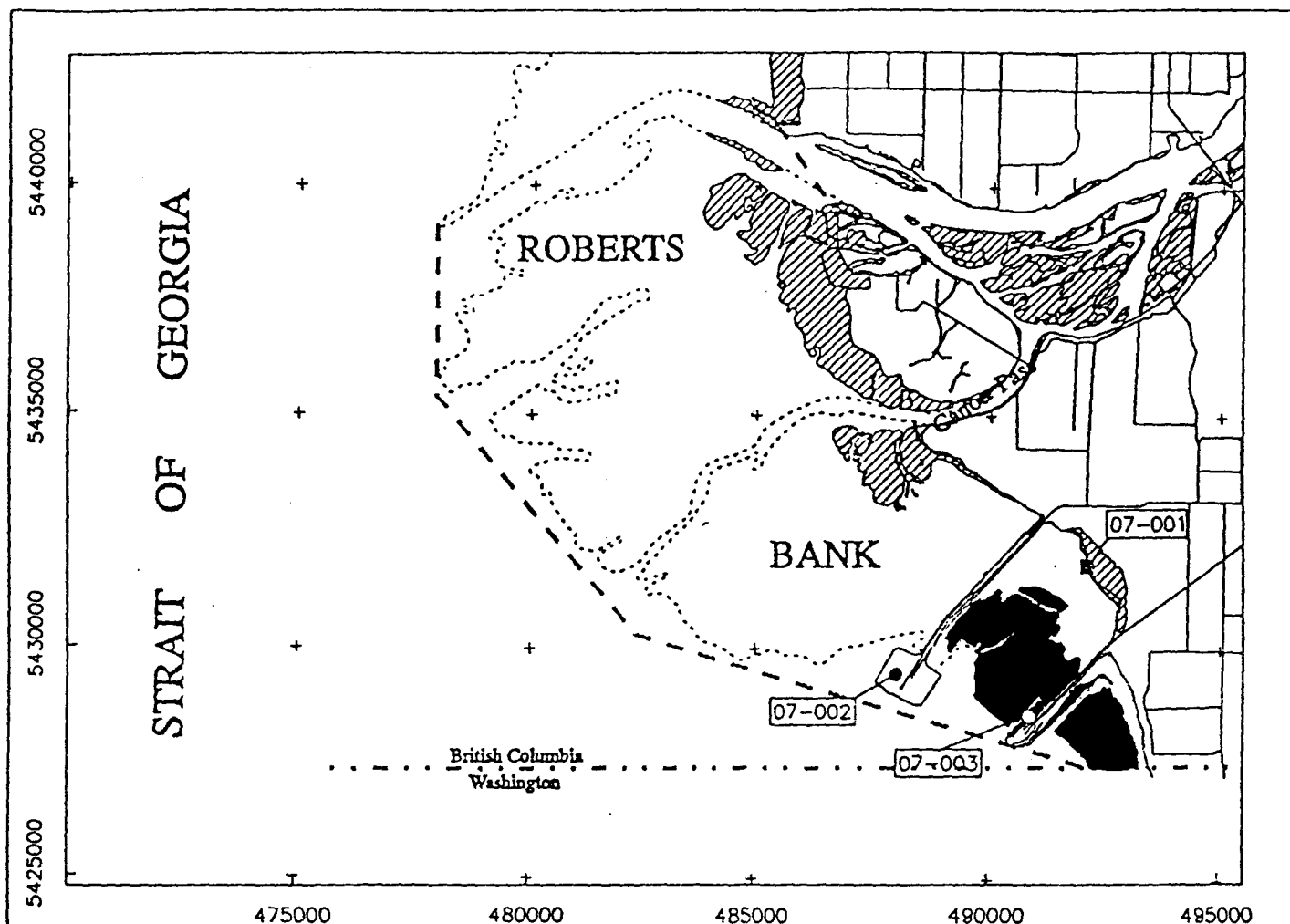


FIGURE 8. HMU 07: ROBERTS BANK

Dashed lines represent the HMU boundaries. Dotted lines correspond to the western delta front. Cross-hatched areas are marsh or other wetland types. Black areas are eelgrass beds. Symbols labeled with a boxed number are Habitat Project sites representing compensation (circle), restoration (square) and creation (triangle).

The following habitat projects are included on this map:

<u>Site No.</u>	<u>Project Name</u>	<u>Category</u>
07-001	Tsawwassen Indian Reserve Breakwater	Compensation
07-002	Roberts Bank Coal Port/Container Terminal	Compensation
07-003	Tsawwassen Terminal - Phase 1 Expansion	Compensation

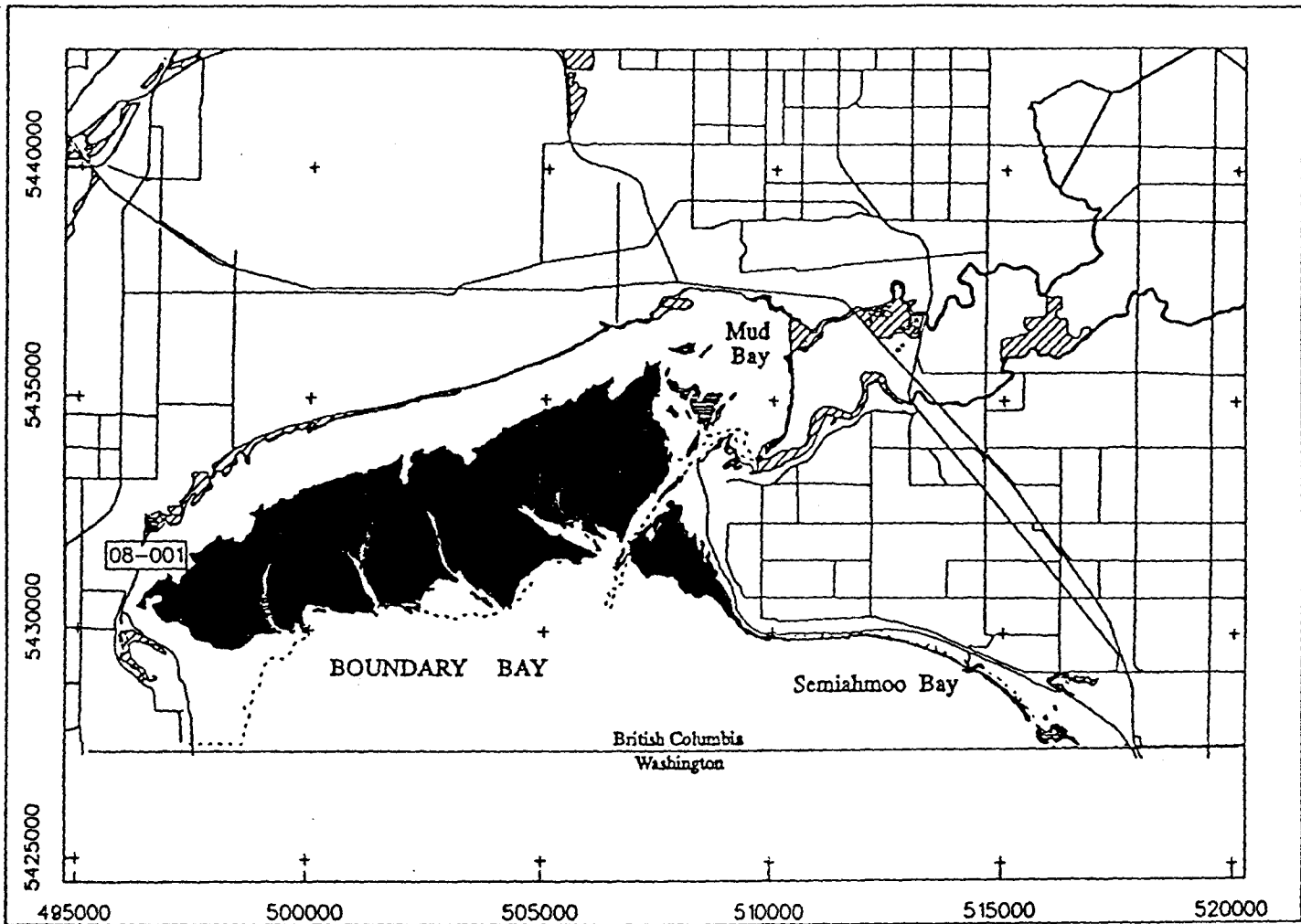


FIGURE 9. HMU 08: BOUNDARY BAY

Dashed lines represent the HMU boundaries. Dotted lines correspond to the western delta front. Cross-hatched areas are marsh or other wetland types. Black areas are eelgrass beds. Symbols labeled with a boxed number are Habitat Project sites representing compensation (circle), restoration (square) and creation (triangle).

The following habitat projects are included on this map:

<u>Site No.</u>	<u>Project Name</u>	<u>Category</u>
08-001	Boundary Bay Log Removal Project	Restoration

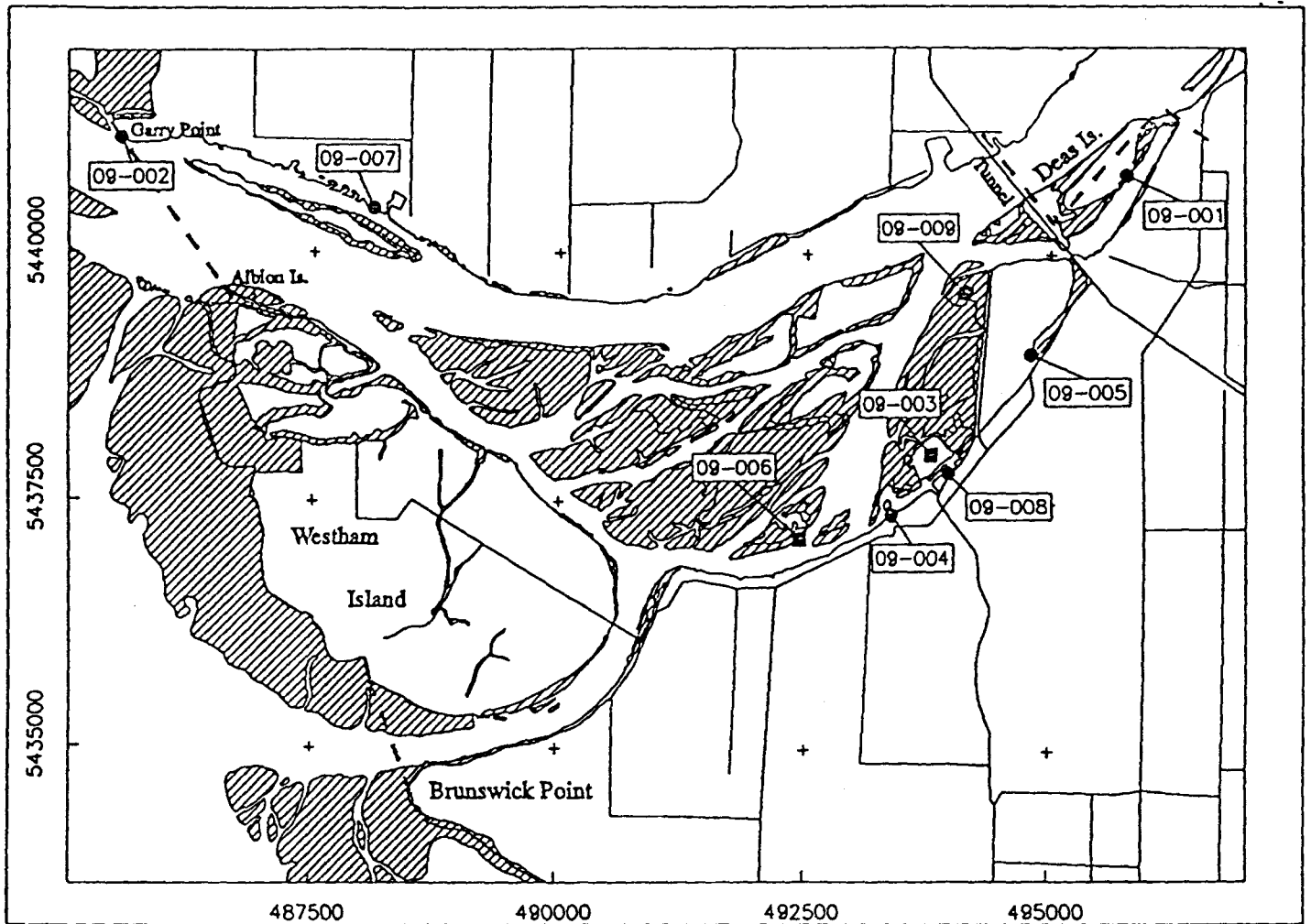


FIGURE 10. HMU 09: SOUTH ARM, Steveston to Deas Island

Dashed lines represent the HMU boundaries. Dotted lines correspond to the western delta front. Cross-hatched areas are marsh or other wetland types. Black areas are eelgrass beds. Symbols labeled with a boxed number are Habitat Project sites representing compensation (circle), restoration (square) and creation (triangle).

The following habitat projects are included on this map:

Site No.	Project Name	Category
09-001	National Metal Compensation Sites, Deas Slough.	Compensation
09-002	Garry Point Park	Compensation
09-003	Ladner Lagoon	Restoration
09-004	Riverwest Condominiums, Ladner.	Compensation
09-005	River Road & Admiral Blvd. Compensation Site.	Compensation
09-006	Clean Marsh And Estuary Project	Restoration
09-007	Paramount Site, Cannery Channel.	Compensation
09-008	Erosion Protection Wall, Ladner Yacht Club.	Compensation

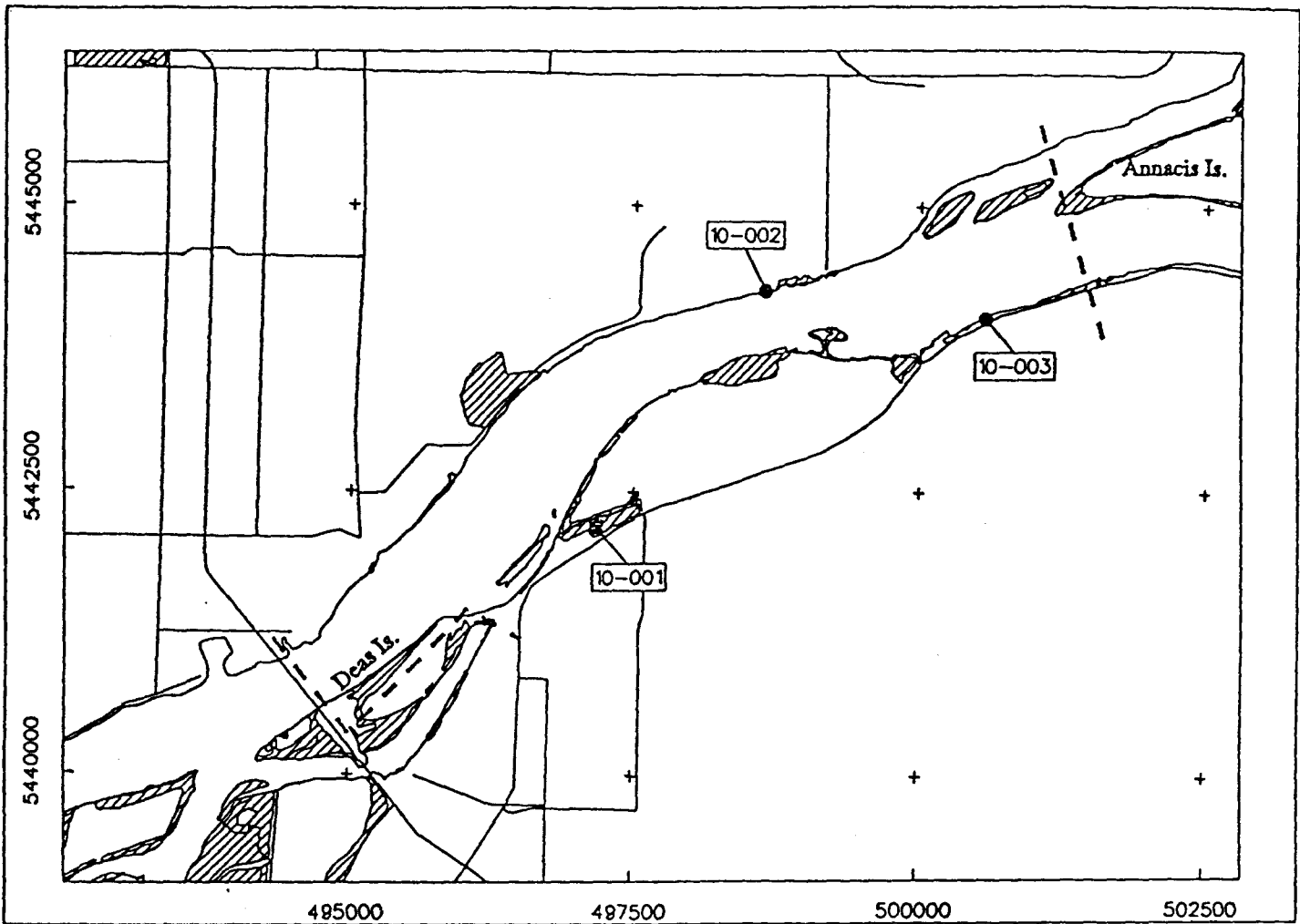


FIGURE 11. HMU 10: SOUTH ARM, Deas Island to Annacis Island

Dashed lines represent the HMU boundaries. Dotted lines correspond to the western delta front. Cross-hatched areas are marsh or other wetland types. Black areas are eelgrass beds. Symbols labeled with a boxed number are Habitat Project sites representing compensation (circle), restoration (square) and creation (triangle).

The following habitat projects are included on this map:

<u>Site No.</u>	<u>Project Name</u>	<u>Category</u>
10-001	Tilbury Slough Restoration Project	Restoration
10-002	Fraser Richmond Landfill, Compensation Site.	Compensation
10-003	Linwood Homes Ltd., Compensation Site.	Compensation

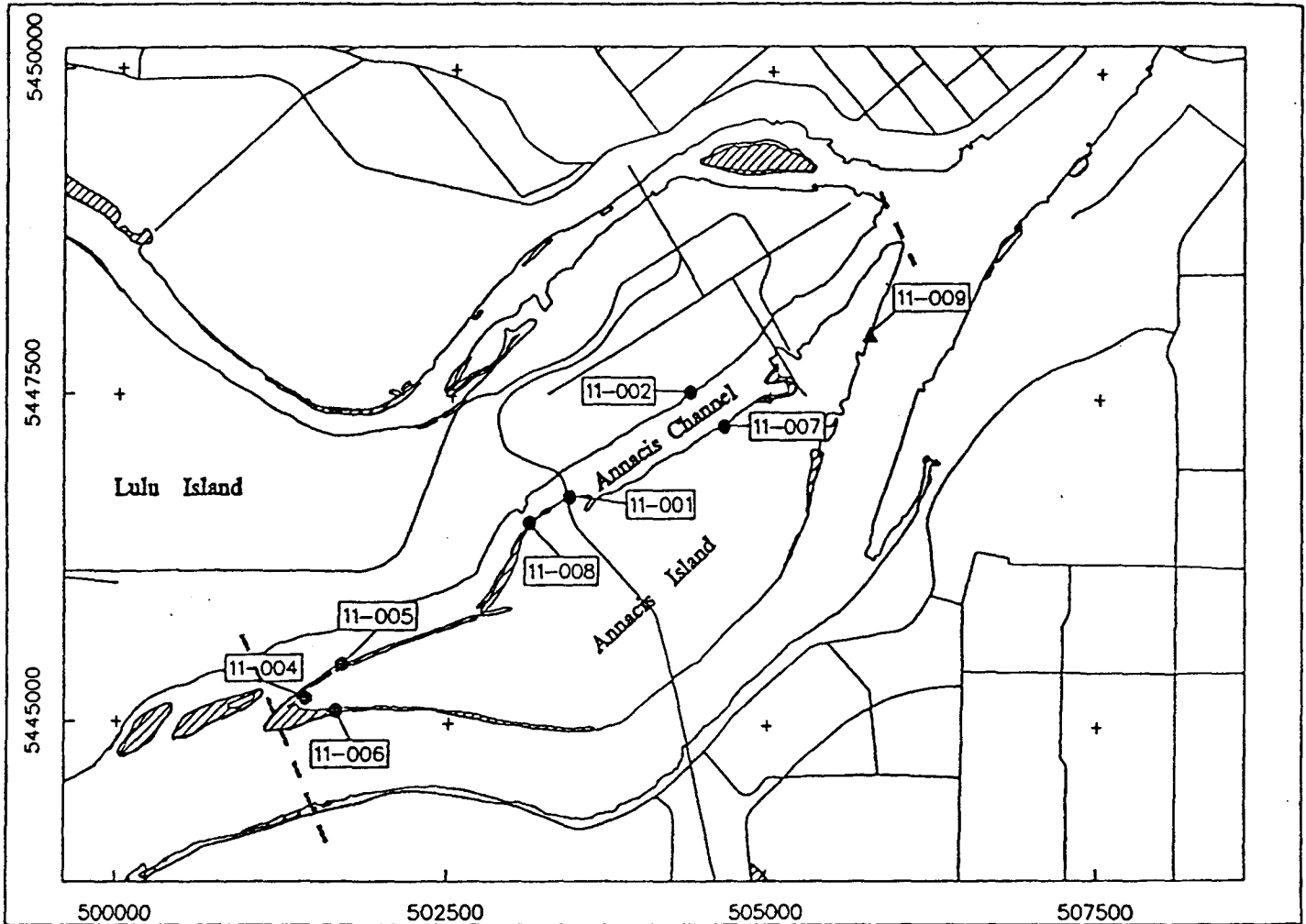


FIGURE 12. HMU 11: SOUTH ARM, Annacis Channel

Dashed lines represent the HMU boundaries. Dotted lines correspond to the western delta front. Cross-hatched areas are marsh or other wetland types. Black areas are eelgrass beds. Symbols labeled with a boxed number are Habitat Project sites representing compensation (circle), restoration (square) and creation (triangle).

The following habitat projects are included on this map:

<u>Site No.</u>	<u>Project Name</u>	<u>Category</u>
11-001	Patrick Is. Habitat Compensation	Compensation
11-002	Michael Goodman, Comp. Site, Annacis Channel.	Compensation
11-004	Grosvenor Habitat Park, S. End of Annacis Is.	Compensation
11-005	Storm Sewer Outfall #11, Annacis Channel	Compensation
11-006	Shoreline Clean-up, Annacis Island.	Restoration
11-007	Titan Construction, Compensation, Annacis Channel.	Compensation
11-008	West Patrick Island Development	Compensation
11-009	Annacis Auto Terminal	Creation

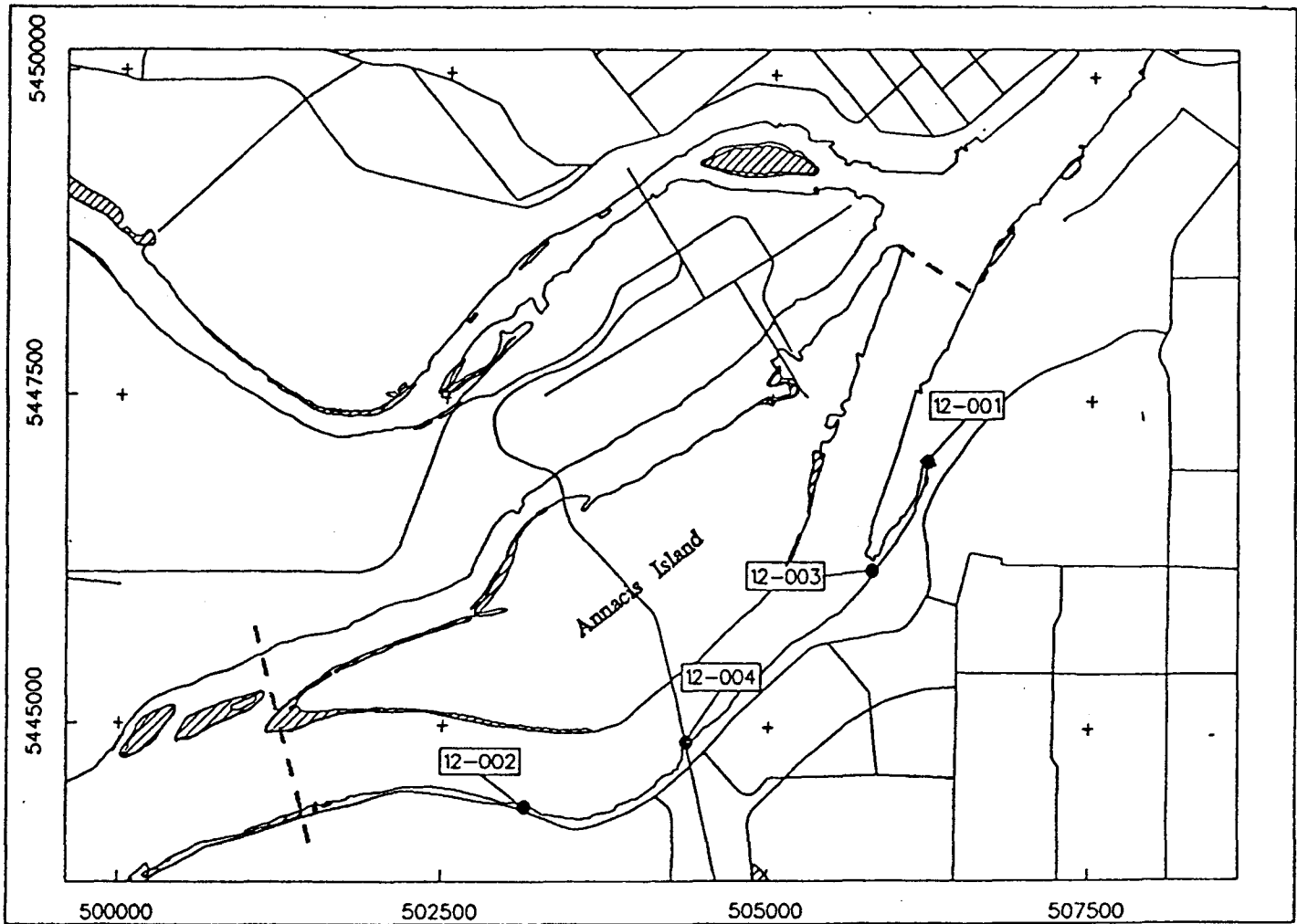


FIGURE 13. HMU 12: SOUTH ARM, City Reach and Annieville Channel

Dashed lines represent the HMU boundaries. Dotted lines correspond to the western delta front. Cross-hatched areas are marsh or other wetland types. Black areas are eelgrass beds. Symbols labeled with a boxed number are Habitat Project sites representing compensation (circle), restoration (square) and creation (triangle).

The following habitat projects are included on this map:

<u>Site No.</u>	<u>Project Name</u>	<u>Category</u>
12-001	Gunderson Slough Habitat Bench	Compensation
12-002	Vito's Compensation Site.	Compensation
12-003	Burlington Northern RR, Gunderson Slough.	Compensation
12-004	Alex Fraser Bridge, South Sand Island	Compensation

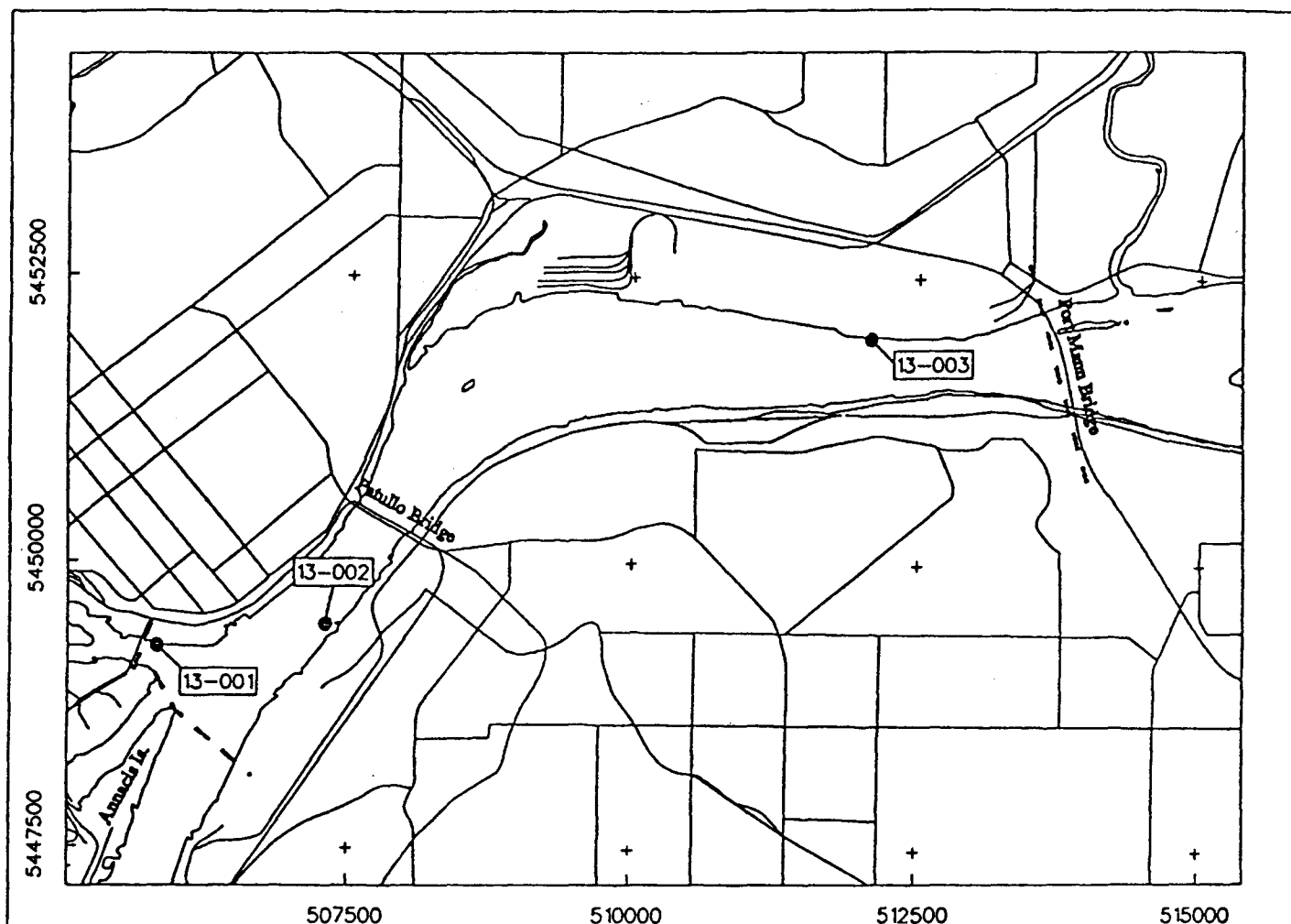


FIGURE 14. HMU 13: SOUTH ARM, Annacis Island to Port Mann Bridge

Dashed lines represent the HMU boundaries. Dotted lines correspond to the western delta front. Cross-hatched areas are marsh or other wetland types. Black areas are eelgrass beds. Symbols labeled with a boxed number are Habitat Project sites representing compensation (circle), restoration (square) and creation (triangle).

The following habitat projects are included on this map:

<u>Site No.</u>	<u>Project Name</u>	<u>Category</u>
13-001	Westminster Quay, Phase 1, Compensation.	Compensation
13-002	Timberland Basin	Compensation
13-003	Port Mann Log Sort, Compensation Site.	Compensation

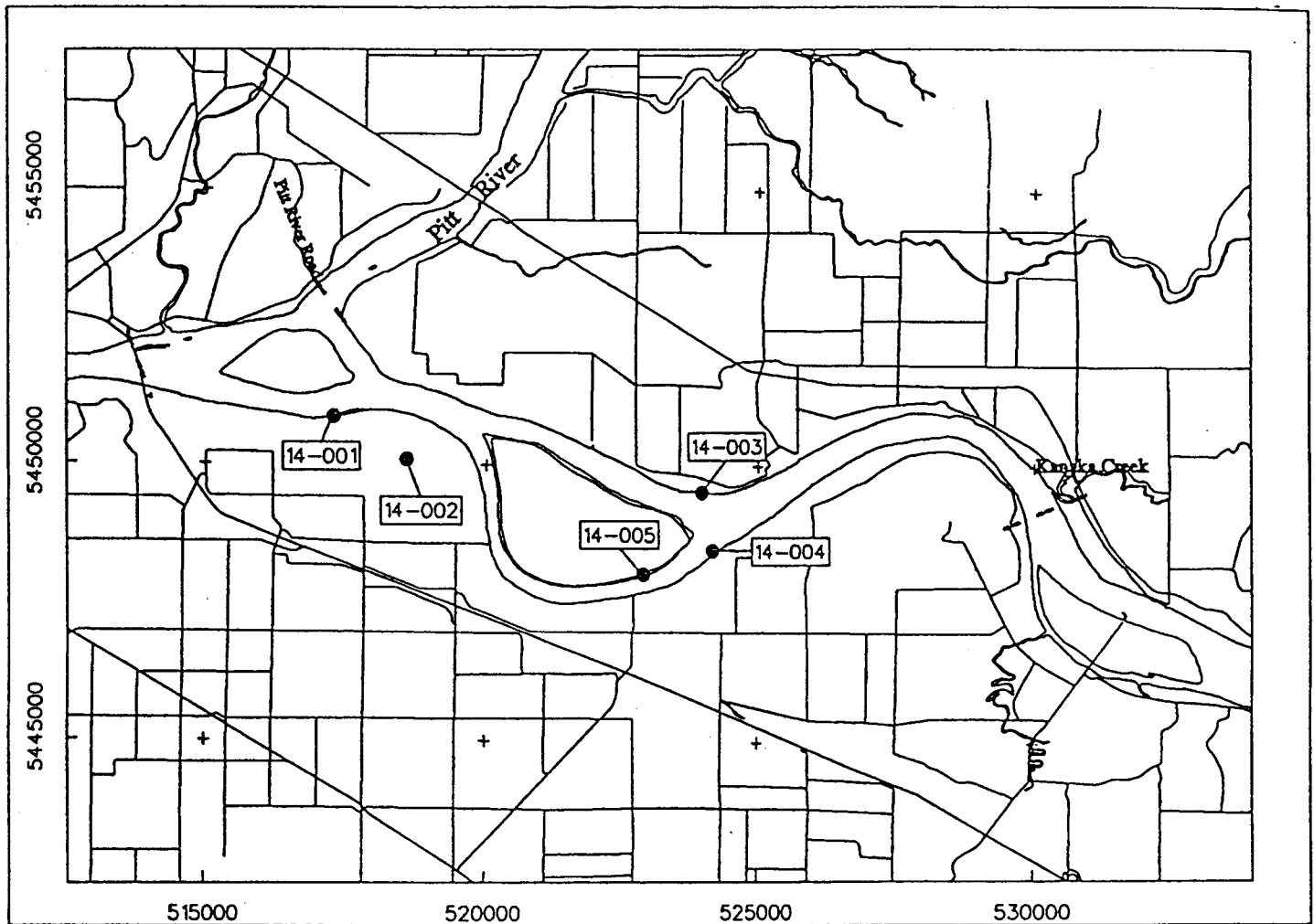


FIGURE 15. HMU 14: SOUTH ARM, Port Mann Bridge to Kanaka Creek

Dashed lines represent the HMU boundaries. Dotted lines correspond to the western delta front. Cross-hatched areas are marsh or other wetland types. Black areas are eelgrass beds. Symbols labeled with a boxed number are Habitat Project sites representing compensation (circle), restoration (square) and creation (triangle).

The following habitat projects are included on this map:

<u>Site No.</u>	<u>Project Name</u>	<u>Category</u>
14-001	C N Railway, Twin Tracking, West Surrey Bend.	Compensation
14-002	C N Intermodal Yard, Surrey Bend.	Compensation
14-003	Marine Way Industries, Port Hammond	Compensation
14-004	Miller Contracting, Compensation, Parsons Channel.	Compensation
14-005	S & R Compensation Site, Barnston Island.	Compensation

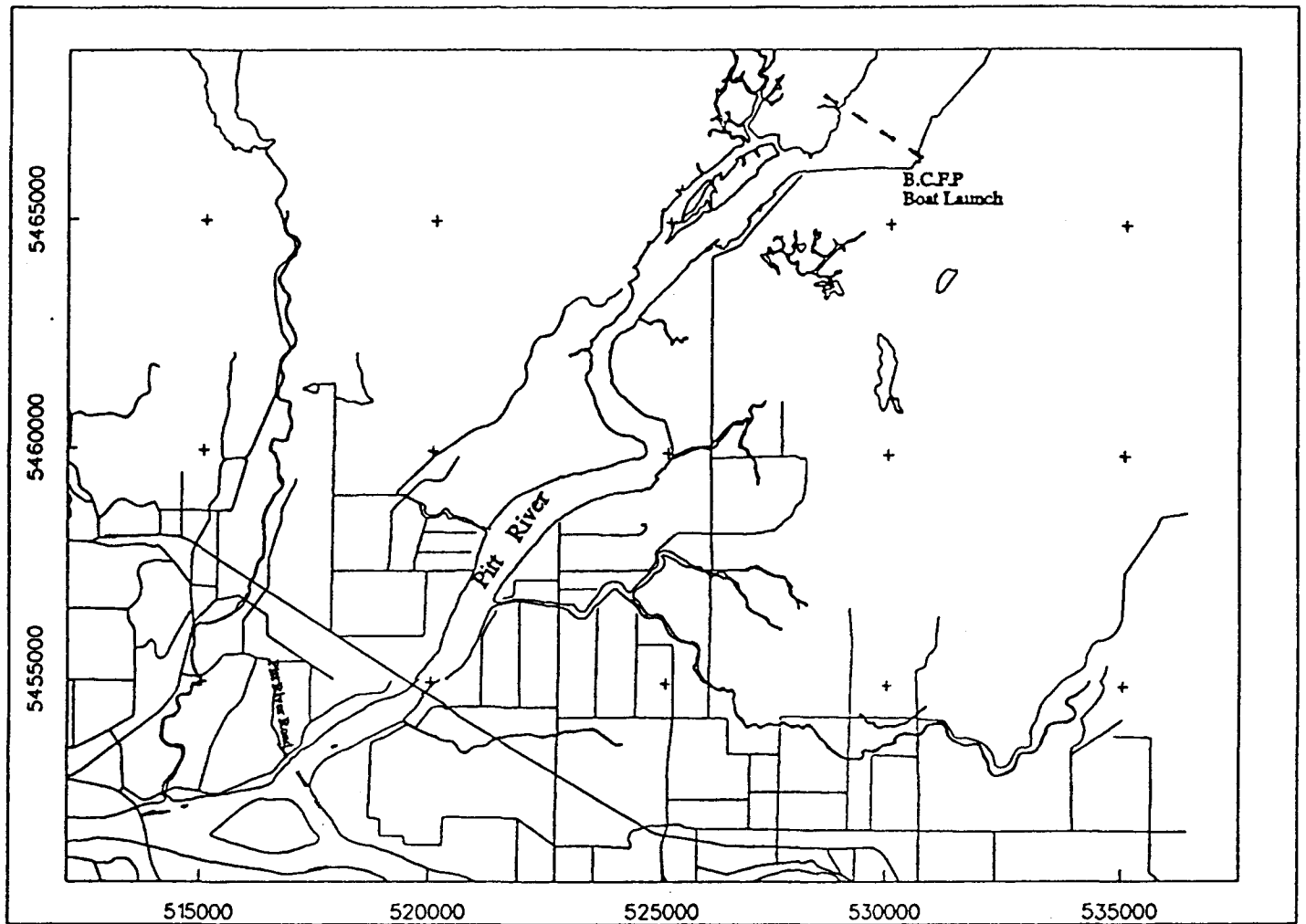


FIGURE 16. HMU 15: PITT RIVER

Dashed lines represent the HMU boundaries. Dotted lines correspond to the western delta front. Cross-hatched areas are marsh or other wetland types. Black areas are eelgrass beds. Symbols labeled with a boxed number are Habitat Project sites representing compensation (circle), restoration (square) and creation (triangle).

APPENDIX

- | | | |
|----|--|-----------------|
| 1. | PHOTOGRAPHS OF SELECTED PROJECT SITES | 3 pages |
| 2. | HABITAT DATABASE PROJECT FORMS | 98 pages |
| 3. | HABITAT COMPENSATION AGREEMENT
Suggested Format (24 October 1994) | 12 pages |

CATEGORY	Restoration	SITE NO.	01-001
STATUS	Complete	C.P.R. NO.	N.A.
<hr/>			
PROJECT NAME	Schenker Warehouse		
PROPOSER	Schenker Distribution		
LOCATION	North Arm, off Trapp Avenue in Burnaby		
UTM GRID REF.	Easting: 503006	Northing: 5448577	
<hr/>			
IMPACT	There was no actual habitat lost and thus no compensation was required.		
<hr/>			
RATIONALE	An experiment by DFO to establish marsh vegetation in the holes of perforated paving stones that was to serve as bank stabilization.		
<hr/>			
FEATURES	Perforated paving stones were used to stabilize the river foreshore. A general shoreline clean-up was also undertaken. No vegetation became established.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	0	0	0
GAINED	0	0	0	0
NET	0	0	0	0

IMPACT DATE	1985	LAST ON-SITE INSPECTION	Sept. 1992
CONSTR. DATE	1985	MONITORED PERIOD	NIL
PLANT DATE	N.A.	REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	NO

VEGETATION GROWING ON-SITE AS OBSERVED IN N.A.

**DOMINANT
SPECIES** N.A.

**ASSOCIATED
SPECIES** N.A.

DOCUMENTATION & CONTACTS

DFO contact: Kevin Conlin

ADDITIONAL COMMENTS

This project was undertaken before the Habitat Policy was in place.

CATEGORY	Compensation	SITE NO.	01-002
STATUS	Complete	C.P.R. NO.	8605-0027
<hr/>			
PROJECT NAME	Olofson & Hewitt Compensation Site.		
PROPOSER	J.H. Olofson And F.W. Hewitt		
LOCATION	North Arm, South bank, 18671 River Road near Nelson Rd.		
UTM GRID REF.	Easting: 498911 Northing: 5449076		
<hr/>			
IMPACT	Loss of marsh due to fill and riprap for boathouse and floating dock.		
<hr/>			
RATIONALE	Shoreline protection work was required for access to a floating facility. A small marsh bench was to replace lost habitat.		
<hr/>			
FEATURES	Small Marsh bench faced with rip-rap. At time of inspection, compensation site was completely covered with bundled logs.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	0	60	0
GAINED	0	0	0	0
NET	0	0	-60	0

IMPACT DATE	1986	LAST ON-SITE INSPECTION	Sept. 1991
CONSTR. DATE	1986	MONITORED PERIOD	NIL
PLANT DATE	1987	REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	NO

VEGETATION GROWING ON-SITE AS OBSERVED IN N.A.

DOMINANT SPECIES N.A.

ASSOCIATED SPECIES N.A.

DOCUMENTATION & CONTACTS

DFO contact: Bob McIndoe

ADDITIONAL COMMENTS

This project was undertaken and completed by the proponent.

CATEGORY	Compensation	SITE NO.	01-003
STATUS	Incomplete	C.P.R. NO.	8812-0105
<hr/>			
PROJECT NAME	Westminster Quay Phase 2, Compensation Site.		
PROPONENT	Quay Developments Ltd.		
LOCATION	North Arm, north bank, opposite east end of Poplar Island.		
UTM GRID REF.	Easting: 505530	Northing: 5449371	
<hr/>			
IMPACT	Loss of unvegetated intertidal habitat due to foreshore filling.		
<hr/>			
RATIONALE	Shoreline protection in conjunction with residential development. Compensation of lost habitat with equivalent habitat at 1:1 or with marsh at 1:0.5		
<hr/>			
FEATURES	Construction of small marsh bench ca. 6m X 18m. Planting does not appear to have been undertaken and site has become naturally colonized with sparse growth.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	501	0	0
GAINED	0	0	108	0
NET	0	-501	108	0

IMPACT DATE	1991	LAST ON-SITE INSPECTION	Sept. 1992
CONSTR. DATE	1991	MONITORED PERIOD	NIL
PLANT DATE	1991	REQUIREMENT FOR REMEDIAL ACTION	YES
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	NO

VEGETATION GROWING ON-SITE AS OBSERVED IN September 1991

DOMINANT SPECIES *Juncus articulatus - Polygonum lapathifolium*

ASSOCIATED SPECIES *Bidens cernua, Typha latifolia, Trifolium repens, Plantago lanceolata, Carex lyngbyei, Vicia americana*

DOCUMENTATION & CONTACTS

Norecol Environmental Consultants Ltd. 1988. Westminster Quay II. Foreshore habitat assessment and compensation plan. Rept. subm. to Quay Dev. Ltd.
DFO contact: Bob McIndoe

ADDITIONAL COMMENTS

Required planting of marsh and riparian vegetation has not occurred. There is a need to undertake some marsh and especially riparian planting.

Remedial action has thus far not been undertaken because there was no legally binding agreement between the proponent and DFO.

CATEGORY	Compensation	SITE NO.	02-001
STATUS	Complete	C.P.R. NO.	N.A.
<hr/>			
PROJECT NAME	Bridgepoint Market Compensation Site, Mitchell Is.		
PROPONENT	Park Georgia Properties		
LOCATION	Mitchell Island, South Shore, foot of Mitchell Road		
UTM GRID REF.	Easting: 493333	Northing: 5449466	
<hr/>			
IMPACT	Loss of marsh, mudflat and riparian fringe due to dredging of marina basin and upland commercial development.		
<hr/>			
RATIONALE	Compensation of marsh at 2:1 ratio; mudflat compensation at 1:1 including clean-up of Wood Island Slough and installation of shear boom.		
<hr/>			
FEATURES	Creation of intertidal marsh and mudflat area from dredged material; installation of shear boom following wood debris removal from Wood Island Slough; use of log booms for erosion protection.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	27,000	7,700	100
GAINED	<u>0</u>	<u>27,000</u>	<u>15,400</u>	<u>0</u>
NET	0	0	7,700	-100

IMPACT DATE	1987	LAST ON-SITE INSPECTION	August 1991
CONSTR. DATE	1988	MONITORED PERIOD	1988-93
PLANT DATE	1988	REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE>NNL GUIDELINE SUCCESSFULLY ACHIEVED?	YES

VEGETATION GROWING ON-SITE AS OBSERVED IN August 1991

DOMINANT SPECIES *Carex lygbyei* - *Scirpus validus* - *Typha latifolia*

ASSOCIATED SPECIES *Lythrum salicaria*

DOCUMENTATION & CONTACTS

DFO Contact: Kevin Conlin & Otto Langer

Williams, G.L. 1993. Mitchell Island marsh compensation project. In: Proc. Can. Coastal Conf.

Whitthouse, T.R., C.D. Levings, and J.S. Macdonald. 1993. Chironomid (Diptera) insects from natural and transplanted estuarine marshes in B.C. In: Proc. Can. Coastal Conf. 1993. Vancouver, B.C., May 5-7.

ADDITIONAL COMMENTS

An area of 8,600 sq.m. of subtidal habitat was dredged to create a boat basin and an undetermined area of subtidal habitat was lost at the habitat compensation site on Mitchell Island. Compensation for dredging impacts and riparian habitat losses were not included in the habitat replacement agreement between DFO and the proponent.

Negotiations between DFO and the NFHC concerning the loss of productive habitat at the Bridgepoint development site ultimately led to the development of the NFHC Environmental Management Plan signed in May 1988. This plan included a shoreline classification, habitat compensation bank, cooperative management program, and shoreline development guidelines.

CATEGORY	Compensation	SITE NO.	02-002
STATUS	Complete	C.P.R. NO.	8803-0019

PROJECT NAME **Richmond Plywood Compensation Site.**
 PROPONENT Richmond Plywood Corp.

LOCATION North Arm, at foot of No. 6 Road and upstream.
 UTM GRID REF. Easting: 495025 Northing: 5449701

IMPACT Loss of intertidal area due to backfilling and riprap for scow loading berth and drainage outfall.

RATIONALE Construction of sawdust scow loading berth. Replacement of habitat lost by foreshore construction for a dredged basin.

FEATURES Replacement and expansion of existing marsh by backfilling onto existing mudflat.

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	530	0	0
GAINED	0	0	635	50
NET	0	-530	635	50

IMPACT DATE	1989	LAST ON-SITE INSPECTION	August 1991
CONSTR. DATE	1989	MONITORED PERIOD	NIL
PLANT DATE	1989	REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE>NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	YES

VEGETATION GROWING ON-SITE AS OBSERVED IN August 1991

DOMINANT SPECIES *Juncus articulatus* - *Scirpus validus* - *Carex lyngbyei*

ASSOCIATED SPECIES *Callitriche stagnalis*, *Eleocharis palustris*, *Lilae scilloides*, *Polygonum spp.*, *Alisma plantago-aquatica*, *Epilobium watsonii*, *Lycopodium americanum*, *Juncus effusus*

DOCUMENTATION & CONTACTS

Mark Adams. unpubl. documents
DFO contact: Bruce Clark

ADDITIONAL COMMENTS

CATEGORY	Creation	SITE NO.	03-001
STATUS	Complete	C.P.R. NO.	N.A.
<hr/>			
PROJECT NAME	Fraser River Park		
PROPONENT	Vancouver City Parks Branch		
LOCATION	North Arm, north bank, foot of Angus Drive		
UTM GRID REF.	Easting: 489055 Northing: 5450238		
<hr/>			
IMPACT	Existing foreshore area before the park was degraded by landfill and slumping.		
<hr/>			
RATIONALE	Vegetation transplanted from Iona & Wood Island, and tidal lagoon created new habitat and provides an interesting landscape view for park visitors.		
<hr/>			
FEATURES	A bench marsh was created from upland and was stabilized using large rock and riprap. Lagoon area provided back water & side channel habitat.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	0	0	100
GAINED	0	10,000	7,000	500
NET	0	10,000	7,000	400

IMPACT DATE	1985	LAST ON-SITE INSPECTION	Sept. 1992
CONSTR. DATE	1985	MONITORED PERIOD	1986-87
PLANT DATE	1986	REQUIREMENT FOR REMEDIAL ACTION	YES
		WAS THE>NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	N.A.

VEGETATION GROWING ON-SITE AS OBSERVED IN August 1991

DOMINANT SPECIES *Carex lyngbyei* - *Juncus balticus* - *Typha latifolia* (*T. angustifolia*)

ASSOCIATED SPECIES *Lythrum salicaria*, *Potentilla pacifica*, *Solidago missouriensis*, *Agropyron repens*, *Vicia americana*, *Iris pseudacorus*, *Populus trichorarpa*

DOCUMENTATION & CONTACTS

Mark Adams. unpubl. documents.
DFO contact: Kevin Conlin

ADDITIONAL COMMENTS

This project was based on a Vancouver Parks Board proposal to provide new habitat in conjunction with park use. As a result, upland (old fill) was converted to aquatic habitat.

This site has been monitored for approx. 2 years as part of an assessment of erosion/debris control structures associated with habitat creation projects. The outstanding feature of this site is the continued state of disrepair that the sheer boom has been in since its installation. The boom has been in disrepair since July, 1991. As a result, much of the interior lagoon complex is choked with log debris. Log debris is a chronic problem at this site.

This site is part of a project undertaken by Dr. C.D. Levings under the Fraser River Action Plan to assess the ecology of compensation marshes in comparison to natural marshes.

CATEGORY	Compensation	SITE NO.	03-002
STATUS	Complete	C.P.R. NO.	8704-0038
<hr/>			
PROJECT NAME	CANFOR Site, end of Richmond Island.		
PROPONENT	Canadian Forest Products Ltd. (CANFOR)		
LOCATION	North Arm, Eburne Slough, W. end of Richmond Island		
UTM GRID REF.	Easting: 489207 Northing: 5450012		
<hr/>			
IMPACT	A subtidal area of 8,106 sq. m. was filled along foreshore to create log storage.		
<hr/>			
RATIONALE	Aquatic habitat compensation of 50% of habitat lost with productive intertidal marsh.		
<hr/>			
FEATURES	Approximately 20,000 cu.m. of old fill was removed to ca. 0 m Geodetic elevation to create 4,053 sq.m. of intertidal marsh. Upon last inspection, marsh growth was sparse.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	8,106	0	0	0
GAINED	0	4,000	53	0
NET	-8,106	4,000	53	0

IMPACT DATE	1987	LAST ON-SITE INSPECTION	Sept. 1992
CONSTR. DATE	1988	MONITORED PERIOD	NIL
PLANT DATE	1989	REQUIREMENT FOR REMEDIAL ACTION	YES
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	YES

VEGETATION GROWING ON-SITE AS OBSERVED IN August 1991

DOMINANT SPECIES *Carex lyngbyei* - *Eleocharis spp.*

ASSOCIATED SPECIES *Polygonum spp.*, *Potentilla pacifica*, *Leersia oryzoides*, *Lycopus americanus*

DOCUMENTATION & CONTACTS

Kistriz Consultants Ltd., 1987. Aquatic habitat creation at Richmond Island, North Arm, Fraser River Estuary, B.C. Report subm. to CANFOR.
DFO contact: Bob McIndoe

ADDITIONAL COMMENTS

Planting of riparian vegetation on the protective berm has to date not been undertaken.

This site is part of a project undertaken by Dr. C.D. Levings under the Fraser River Action Plan to assess the ecology of compensation marshes in comparison to natural marshes.

CATEGORY	Compensation	SITE NO.	03-003
STATUS	Complete	C.P.R. NO.	8909-0075

PROJECT NAME **CANFOR Site, North Shore of Eburne Slough.**
 PROPONENT Canadian Forest Products Ltd.

LOCATION North Arm, north bank, Eburne Slough
 UTM GRID REF. Easting: 489780 Northing: 5449769

IMPACT Loss and impact on foreshore habitats due to shoreline realignment and riprap.

RATIONALE Shoreline was realigned and stabilized after demolition of the Huntington-Merritt Shingle Mill. A marsh bench was required.

FEATURES Creation of marsh bench 2.5m X 250m incorporated into riprap structure.

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	100	4,325	575	0
GAINED	0	0	625	0
NET	-100	-4,325	50	0

IMPACT DATE	1989	LAST ON-SITE INSPECTION	Sept. 1992
CONSTR. DATE	1990	MONITORED PERIOD	NIL
PLANT DATE	1992	REQUIREMENT FOR REMEDIAL ACTION	YES
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	NO

VEGETATION GROWING ON-SITE AS OBSERVED IN

**DOMINANT
SPECIES**

**ASSOCIATED
SPECIES**

DOCUMENTATION & CONTACTS

Kistriz Consultants Ltd. 1988. Existing aquatic habitat and proposed habitat creation at the Huntington-Merrit Shingle Mill. Rept. subm. to CANFOR.
DFO contact: Bob McIndoe

ADDITIONAL COMMENTS

The shortfall of compensation area on the marsh bench was to have been made up by marsh restoration work on the other side of the Eburne Slough. To date this work has not been completed.

Construction material (concrete rubble) which was intended to be used as footing material for marsh restoration work has been dumped into a pile down the bank of the slough. This material should either be removed or used for its intended purpose.

CATEGORY	Compensation	SITE NO.	04-001
STATUS	Complete	C.P.R. NO.	8801-0005
<hr/>			
PROJECT NAME	Deering Island Compensation Site.		
PROPONENT	Deering Island Developments Ltd.		
LOCATION	North Arm, north bank, at Deering Island (Celtic Slough)		
UTM GRID REF.	Easting: 486367	Northing: 5451676	
<hr/>			
IMPACT	Impact on foreshore habitats due to housing development and private moorage.		
<hr/>			
RATIONALE	Shoreline protection for housing development. Compensation at 2:1 (marsh:marsh), 1:2 (marsh:mudflat), 1:1 (riparian:riparian), 1:2 (marsh:riparian).		
<hr/>			
FEATURES	Marsh bench protected by riprap and a string boom.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	3,944	649	486
GAINED	0	0	3,461	105
NET	0	-3,944	2,812	-381

IMPACT DATE	1989	LAST ON-SITE INSPECTION	Sept. 1992
CONSTR. DATE	1990	MONITORED PERIOD	1991-92
PLANT DATE	1990	REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE>NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	YES

VEGETATION GROWING ON-SITE AS OBSERVED IN August 1991

DOMINANT SPECIES *Carex lyngbyei*, *Scirpus validus*

ASSOCIATED SPECIES *Lilae scilloides*, *Typha latifolia*, *Alisma plantago-aquatica*, *Polygonum spp.*, *Eleocharis parvula*, *Eleocharis palustris*, *Potentilla pacifica*, *Cirsium arvense*, *Limosella aquatica*

DOCUMENTATION & CONTACTS

Adams, M. 1988. A habitat compensation proposal for Deering Island Development, Vancouver, B.C. Rept. subm. to M. Geller & Assoc. Ltd.
DFO contact: Bruce Clark & Kevin Conlin

ADDITIONAL COMMENTS

Replacement focused on providing marsh only. Riparian losses should have been replaced on an equal basis with riparian compensation and been a condition for project approval. The existing riparian plantings are subject to ongoing impacts from human disturbances (e.g., equestrian users, municipal maintenance staff).

The shear boom grounds on the rock riprap and marsh fringe. Hence it should be moved and redesigned and strengthened.

Three small red-coded marsh areas were preserved. The intertidal flats lost (2,284 sq.m.) by the construction of the copensation marsh were comprised primarily of construction rubble.

The concrete lock-block wall around Deering Island is biologically very sterile and should have incorporated some environmentally designed features.

This site is part of a project undertaken by Dr. C.D. Levings under the Fraser River Action Plan to assess the ecology of compensation marshes in comparison to natural marshes.

CATEGORY	Restoration	SITE NO.	04-002
STATUS	Complete	C.P.R. NO.	9011-0100
<hr/>			
PROJECT NAME	Dentritic Channel Enhancement		
PROPONENT	Department Of Fisheries & Oceans, SEP		
LOCATION	McDonald Slough, north shore.		
UTM GRID REF.	Easting: 486037	Northing: 5451136	
<hr/>			
IMPACT	Channels were developed and in the process some existing high marsh was lost by excavation and sidecasted soil.		
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RATIONALE	Channelization would improve access to juvenile fish and flushing of fish food into MacDonald Slough.		
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FEATURES	Excavation of a series of dendritic channels using a total area of 6,000 sq.m of existing marsh and creation of riparian islands from sidecast materials.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	0	2,200	0
GAINED	0	2,000	0	200
NET	0	2,000	-2,200	200

IMPACT DATE	1990	LAST ON-SITE INSPECTION	August 1991
CONSTR. DATE	1990	MONITORED PERIOD	1991-92
PLANT DATE	N.A.	REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE>NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	N.A.

VEGETATION GROWING ON-SITE AS OBSERVED IN August 1991

DOMINANT SPECIES *Typha latifolia* - *Scirpus validus*

ASSOCIATED SPECIES *Impatiens capensis*, *Lycopus americanus*, *Potentilla pacifica*, *Oenanthe sarmentosa*, *Rumex conglomeratus*, *Lythrum salicaria*, *Athyrium filix-femina*, *Solidago missouriensis*

DOCUMENTATION & CONTACTS

DFO contact: Kevin Conlin & Bruce Clark

ADDITIONAL COMMENTS

This part of Iona Island was diked and drained at the turn of the 20th century. Over time this area became poorly flushed and developed a high marsh community. The objective of the SEP project was to improve tidal flushing and increase the export of invertebrates and detritus into the estuary.

CATEGORY	Compensation	SITE NO.	05-001
STATUS	Complete	C.P.R. NO.	8805-0061
<hr/>			
PROJECT NAME	Miller Road Pump Station		
PROPONENT	Corporation Of Richmond		
LOCATION	Middle Arm, north bank, foot of Morey Channel Bridge		
UTM GRID REF.	Easting: 489969	Northing: 5448670	
<hr/>			
IMPACT	Loss of sedge marsh growing in between riprap due to reconstruction of drainage outfall.		
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RATIONALE	Construction of new pump house. Compensation ratio of 2:1 for marsh lost.		
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FEATURES	Creation of a 7m X 11m marsh bench and a 10 sq.m silt filled riprap structure. Marsh was planted in the spring of 1992.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	0	20	0
GAINED	0	0	70	0
NET	0	0	50	0

IMPACT DATE	1988	LAST ON-SITE INSPECTION	Sept. 1992
CONSTR. DATE	1991	MONITORED PERIOD	NIL
PLANT DATE	1992	REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	YES

VEGETATION GROWING ON-SITE AS OBSERVED IN September 1992

DOMINANT SPECIES *Carex lyngbyei, Iris pseudacorus*

ASSOCIATED SPECIES

DOCUMENTATION & CONTACTS

Gary Williams, pers. comm.
DFO contact: Bob McIndoe

ADDITIONAL COMMENTS

There was some delay in completing the compensation work due to municipal misdirections.

CATEGORY	Compensation	SITE NO.	05-002
STATUS	Complete	C.P.R. NO.	8910-0078

PROJECT NAME **No. 2 Road Bridge.**
 PROPONENT City Of Richmond

LOCATION South bank of Middle Arm, River Rd., w. of Lynas Lane.
 UTM GRID REF. Easting: 487889 Northing: 5446600

IMPACT Impact due to construction of No. 2 Rd. Bridge

RATIONALE The created marsh area was designed to adequately compensate a "worst-case" scenario for habitat losses. Compensation preceeded construction.

FEATURES Upland dredge spoil area was removed to create intertidal marsh lagoon protected by barrier island and debris screens.

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	1,675	1,325	0
GAINED	0	0	4,500	300
NET	0	-1,675	3,175	300

IMPACT DATE	1993	LAST ON-SITE INSPECTION	Sept. 1992
CONSTR. DATE	1991	MONITORED PERIOD	1991-95
PLANT DATE	1991	REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE>NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	YES

VEGETATION GROWING ON-SITE AS OBSERVED IN September 1991

DOMINANT SPECIES *Carex lyngbyei*

ASSOCIATED SPECIES *Lythrum salicaria, Typha latifolia, Scirpus validus, Agrostis alba*

DOCUMENTATION & CONTACTS

Dames & Moore. 1991. Initial Environmental Evaluation. No. 2 Road Bridge Project. Rept. subm. to Transport Canada.
Mark Adams. unpubl. documents.
DFO contact: Kevin Conlin, Bob McIndoe, Steve Macfarlane

ADDITIONAL COMMENTS

The encroachment into red-coded habitat was justified on the basis that only one bridge alignment was possible that would avoid serious traffic congestions near the hospital and fire hall on Gilbert Road.

Based on a site inspection in May 1993, preliminary indications are that marsh losses thus far are only 10% of the predicted "worst-case" scenario indicated in the habitat balance sheet. However, long-term shading impacts (from the bridge) may further reduce marsh growth resulting in overall losses close to the originally predicted "worst-case" scenario.

The compensation habitat was constructed prior to the marsh losses. Monitoring of fish and vegetation is currently being conducted at the compensation and a control site.

CATEGORY	Creation	SITE NO.	06-001
STATUS	Complete	C.P.R. NO.	8706-0065

PROJECT NAME **Dredge Spoil Habitat Creation, Steveston Jetty.**

PROPONENT Transport Canada & Canadian Coast Guard

LOCATION Steveston Jetty, north side

UTM GRID REF. Easting: 483182 Northing: 5442206

IMPACT Temporary loss of fish food organisms underneath sand pad.

RATIONALE Estuarine habitat creation using dredge spoil. Marsh vegetation from natural colonization and planting.

FEATURES A 10 ha sand island (ca. 3 ha intertidal) was created using dredged material. The northwest facing shore was protected with a concrete breakwater and filter cloth.

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	100,000	0	0
GAINED	0	20,000	0	0
NET	0	-80,000	0	0

IMPACT DATE	1987	LAST ON-SITE INSPECTION	
CONSTR. DATE	1987	MONITORED PERIOD	NIL
PLANT DATE	1987	REQUIREMENT FOR REMEDIAL ACTION	YES
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	N.A.

VEGETATION GROWING ON-SITE AS OBSERVED IN

**DOMINANT
SPECIES**

**ASSOCIATED
SPECIES**

DOCUMENTATION & CONTACTS

DFO contact: Kevin Conlin & Otto Langer
CWS contact: Sean Boyd

ADDITIONAL COMMENTS

Monitoring of the site should be undertaken to determine marsh colonization and island stability. An assessment should be made of the integrity of the concrete pile and filter cloth stabilization wall that was constructed prior to sand placement.

Sean Boyd, CWS, undertook some small transplanting tests at the site; however, all of these plants have disappeared. The last time Sean inspected the site in 1990, there was no marsh vegetation present.

CATEGORY	Compensation	SITE NO.	07-001
STATUS	Complete	C.P.R. NO.	8603-0018
<hr/>			
PROJECT NAME	Tsawwassen Indian Reserve Breakwater		
PROPONENT	Department of Indian & Northern Affairs		
LOCATION	Roberts Bank foreshore, Tsawwassen saltmarsh.		
UTM GRID REF.	Easting: 492103	Northing: 5431854	
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IMPACT	Some saltmarsh and intertidal flat area was lost underneath the footprint of the existing storm surge breakwater.		
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RATIONALE	Storm surge barrier was built in 1986 to upgrade the dike partially completed in 1975. Openings were required to permit tidal exchange with saltmarsh.		
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FEATURES	Flood control breakwater. The constructed breakwater also alleviated erosion problems and the progressive loss of saltmarsh.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	0	30,000	0
GAINED	0	0	0	0
NET	0	0	-30,000	0

IMPACT DATE	1985	LAST ON-SITE INSPECTION	
CONSTR. DATE	1985	MONITORED PERIOD	NIL
PLANT DATE	N.A.	REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	NO

VEGETATION GROWING ON-SITE AS OBSERVED IN

**DOMINANT
SPECIES**

**ASSOCIATED
SPECIES**

DOCUMENTATION & CONTACTS

Bernard, D.J., and V.G. Bartnik. 1987. Tsawwassen Indian Reserve flood control works. Post-project environmental analysis. Environment Canada, IWD.

John Lutermuer. Geological Survey Canada, unpubl. docs.

Hillaby, F.B. and D.T. Barrett. 1976. Vegetation communities of a Fraser River salt marsh. Fish. Mar. Serv. Tech. Rept. PAC/T-76-14.

ADDITIONAL COMMENTS

Attempts in 1975 to construct a dike around Tsawwassen salt marsh were stopped by DFO because of the significant wetland loss that would have resulted. A decade later, a storm surge breakwater was built on the existing dike to alleviate existing and potential erosion problems of the upland shoreline. A number of openings were incorporated into the breakwater as mitigation features to retain tidal flushing in the saltmarsh.

Marsh lost was calculated by using the "As Constructed Drawings" of Associated Engineering Ltd. The length and bottom width of the 1975 dyke was 2,033 m and 10.7 m respectively (= 2.2 ha). The length and bottom width of the 1985 breakwater is 3,011 m and 13.7 m respectively (= 4.1 ha). The surface length and width of the landward canal is 760 m and 15 m respectively (= 1.1 ha). Therefore, the total area of saltmarsh lost due to the 1985 structure is 3.0 ha.

At present it is uncertain to what degree habitat lost underneath the breakwater has been compensated by erosion protection of the saltmarsh.

CATEGORY	Compensation	SITE NO.	07-002
STATUS	Incomplete	C.P.R. NO.	N.A.
<hr/>			
PROJECT NAME	Roberts Bank Coal Port Terminal Expansion		
PROPOSER	Vancouver Port and Westshore Terminal		
LOCATION	Roberts Bank		
UTM GRID REF.	Easting: 488032	Northing: 5429472	

IMPACT Loss of intertidal and subtidal habitat through expansion of the terminal loading facility and ship turning basin in 1981-83.

RATIONALE Expansion of coal port facility. Habitat losses have been studied and documented but habitat compensation has only been partially successful.

FEATURES Pilot plantings of eelgrass have been undertaken and rock berms (crest protection) built to prevent further erosion at the head of the turning basin. An artificial reef was also constructed.

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	850,000	30,000	0	0
GAINED	0	0	0	0
NET	-850,000	-30,000	0	0

IMPACT DATE	1981	LAST ON-SITE INSPECTION	
CONSTR. DATE	1982	MONITORED PERIOD	
PLANT DATE		REQUIREMENT FOR REMEDIAL ACTION	YES
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	NO

VEGETATION GROWING ON-SITE AS OBSERVED IN

**DOMINANT
SPECIES**

**ASSOCIATED
SPECIES**

DOCUMENTATION & CONTACTS

Levings, C.D. 1985. Juvenile salmonid use of habitats altered by a Coal Port in the Fraser River Estuary, British Columbia. *Marine Pollution Bulletin*. 16(6):248-2554.
Tarbotton, M., J. Luternauer, and M. Mattila. 1993. Tidal flat response to development and mitigation work at Roberts Bank, Fraser River Delta, B.C. In: *Proc. Can. Coastal Conf.*, Van

ADDITIONAL COMMENTS

Expansion of the Westshore Terminal facility resulted in the loss of approximately 85 ha of shallow subtidal and 30 ha of intertidal habitat and the dredging of 95 ha of subtidal bottom.

Hard surfaces (eg., rip-rap, pilings) built as part of the expansion project have provided some algal productivity in the area. Saltmarsh and eelgrass plantings were undertaken on a pilot scale only.

There is also evidence that detritic channels have grown and eelgrass beds have expanded 800 m inshore in the intercauseway tidal flats since construction of the two causeways (Tarbotton et al. 1993).

Habitat compensation has not yet been completed and \$400,00 remains of the original \$1.5 million compensation fund.

CATEGORY	Compensation	SITE NO.	07-003
STATUS	Incomplete	C.P.R. NO.	9012-0107
<hr/>			
PROJECT NAME	Tsawwassen Terminal - Phase 1 Expansion		
PROPONENT	B.C. Ferry Corporation		
LOCATION	B.C. Ferry Terminal, north side		
UTM GRID REF.	Easting: 490852 Northing: 5428561		
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IMPACT	Habitat losses of cobble/gravel beach, mudflat, and eelgrass beds were due to the Phase I expansion as well as to the area filled for habitat compensation..		
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RATIONALE	Expansion of ferry terminal and parking area. Habitat losses were to be compensated on an existing subtidal and intertidal area.		
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FEATURES	Present compensation consists of 96,000 transplanted eelgrass (<i>Zostera marina</i>) sprigs		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	42,500	70,000	0	0
GAINED	0	48,000	0	0
NET	-42,500	-22,000	0	0

IMPACT DATE	1990	LAST ON-SITE INSPECTION	Sept. 1992
CONSTR. DATE	1990	MONITORED PERIOD	1992-97
PLANT DATE	1991	REQUIREMENT FOR REMEDIAL ACTION	YES
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	NO

VEGETATION GROWING ON-SITE AS OBSERVED IN

**DOMINANT
SPECIES**

**ASSOCIATED
SPECIES**

DOCUMENTATION & CONTACTS

Secter Environmental Resource Consulting. 1991. Environmental Management Report.
Tsawwassen Ferry Terminal Expansion. Addendum. Rept. subm. to B.C. Ferry Corp.
Anne Moody. unpubl. documents.
DFO contact: Bob McIndoe, Kevin Conlin, Steve Macfarlane

ADDITIONAL COMMENTS

In the spring of 1993 the following information was available on habitat losses and gains:

Subtidal (+ eelgrass): losses 42,500 sq.m. gains not required except for eelgrass
Eelgrass (part of above): losses 28,860 sq.m. gains 57,700 sq. m. (planted in 1992)

Dentritic outflow channels: losses 70,000 sq.m. gains not required
Tidal marsh losses 0 sq.m. gains 48,600 (proposed)
Cobble-gravel-riprap losses 1,023 m. gains 1,393 m

CATEGORY	Restoration	SITE NO.	08-001
STATUS	Complete	C.P.R. NO.	N.A.
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PROJECT NAME	Boundary Bay Log Removal Project		
PROPONENT	B.C. MELP, Ducks Unlimited and TNT		
LOCATION	Boundary Bay, Grauer Beach (between 64th and 72nd Streets)		
UTM GRID REF.	Easting: 496614	Northing: 5432249	
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IMPACT	Intertidal zone including saltmarsh had been covered and degraded for several decades by considerable accumulations of driftwood. A 50% areal loss of marsh was attributed to the wood debris.		
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RATIONALE	The enhancement work cleaned up 34 ha of foreshore habitat at a total cost of \$192,000. The saltmarsh has recovered to its former productive capacity.		
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FEATURES	Clean-up and removal of log debris and driftwood which was burned on-site.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	0	0	0
GAINED	0	0	17,000	0
NET	0	0	17,000	0

IMPACT DATE	N.A.	LAST ON-SITE INSPECTION	
CONSTR. DATE	1984	MONITORED PERIOD	
PLANT DATE	N.A.	REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	N.A.

VEGETATION GROWING ON-SITE AS OBSERVED IN

**DOMINANT
SPECIES**

**ASSOCIATED
SPECIES**

DOCUMENTATION & CONTACTS

Ministry of Environment, Lands and Parks, Fish & Wildlife Service: Jack Evans

ADDITIONAL COMMENTS

CATEGORY	Compensation	SITE NO.	09-001
STATUS	Complete	C.P.R. NO.	8610-0068
PROJECT NAME	National Metal Compensation Site, Deas Slough.		
PROPONENT	National Metal Corp. Ltd.		
LOCATION	Deas Slough, north shore		
UTM GRID REF.	Easting: 495749	Northing: 5440812	

IMPACT Loss and alienation of foreshore habitats due to dredged material fill, riprap, and berthing structures on Lulu Island foreshore.

RATIONALE Reconstruction of marsh habitat offsite within Deas slough.

FEATURES Construction of two marsh platforms protected by steep sloped riprap: 1. 7mX200m
2. 6mX280m.

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	10,500	8,500	2,400	300
GAINED	0	0	3,100	0
NET	-10,500	-8,500	700	-300

IMPACT DATE	1989	LAST ON-SITE INSPECTION	Sept. 1992
CONSTR. DATE	1990	MONITORED PERIOD	NO
PLANT DATE	1990	REQUIREMENT FOR REMEDIAL ACTION	YES
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	NO

VEGETATION GROWING ON-SITE AS OBSERVED IN August 1991

DOMINANT SPECIES *Juncus articulatus* - *Eleocharis palustris* - *Lythrum salicaria*

ASSOCIATED SPECIES *Phalaris arundinaceae*, *Calamagrostis canadensis*, *Epilobium watsonii*, *Lycopus americanus*,
Bidens cernus, *Potentilla pacifica*, *Sagittaria latifolia*

DOCUMENTATION & CONTACTS

P.A. Harder and Associates Ltd. 1989. A proposal to develop marsh habitat and provide bank stability in Deas Slough. Rept. subm. to GVRD, Parks Department.
Also: R.U. Kistriz; B.C. Research; Norecol.
DFO contact: Kevin Conlin, Otto Langer

ADDITIONAL COMMENTS

The port facility was built in a red-coded conservation area. Due to inability to build an on-site habitat compensation structure, off-site compensation was permitted in Deas Slough.

The as-built compensation structure (3,100 sq.m.) is 2,500 sq.m. short of the compensation marsh area of 5,600 sq.m. required in the compensation agreement.

This site is part of a project undertaken by Dr. C.D. Levings under the Fraser River Action Plan to assess the ecology of compensation marshes in comparison to natural marshes.

CATEGORY	Compensation	SITE NO.	09-002
STATUS	Complete	C.P.R. NO.	8701-0008
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PROJECT NAME	Garry Point Park		
PROPONENT	Richmond Municipality		
LOCATION	South Arm, Gary Point, Steveston.		
UTM GRID REF.	Easting: 485540	Northing: 5441164	
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IMPACT	Alienation of intertidal habitat including marsh due to infilling with sand and rock to develop park foreshore.		
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RATIONALE	Replacement of habitat losses due to development of a foreshore park. Marsh replacement required at 2:1.		
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FEATURES	Construction of three marsh pockets protected by rip-rap.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	0	840	0
GAINED	0	0	1,680	0
NET	0	0	840	0

IMPACT DATE	1988	LAST ON-SITE INSPECTION	Sept. 1992
CONSTR. DATE	1988	MONITORED PERIOD	
PLANT DATE	1989	REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	YES

VEGETATION GROWING ON-SITE AS OBSERVED IN September 1991

DOMINANT SPECIES *Carex lyngbyei - Scirpus validus*

ASSOCIATED SPECIES *Eleocharis palustris, Polygonum spp.*

DOCUMENTATION & CONTACTS

Mark Adams. unpubl. documents.
DFO contact: Bruce Clark, Kevin Conlin, Otto Langer

ADDITIONAL COMMENTS

CATEGORY	Restoration	SITE NO.	09-003
STATUS	Complete	C.P.R. NO.	N.A.
<hr/>			
PROJECT NAME	Ladner Lagoon		
PROponent	Department Of Fisheries And Oceans		
LOCATION	Ladner, next to Ladner Harbour Park		
UTM GRID REF.	Easting: 493803	Northing: 5437999	
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IMPACT	A 6 ha area of marsh and riparian habitat had been used as a domestic sewage lagoon from 1964 until it was decommissioned in 1986. Habitat losses were also associated with the 1974 construction of the Ladner boat basin.		
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RATIONALE	Restored exchange of tidal water with Ladner slough and improved wildlife use. Also, compensation for construction of Ladner boat basin.		
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FEATURES	A dyke was breached to permit tidal flooding, channels were excavated, sidecast material was used to create islands and berms, and vegetation planted.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	0	0	0
GAINED	0	7,500	50,000	1,200
NET	0	7,500	50,000	1,200

IMPACT DATE	1964	LAST ON-SITE INSPECTION	Sept. 1992
CONSTR. DATE	1990	MONITORED PERIOD	1992
PLANT DATE	1990	REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	N.A.

VEGETATION GROWING ON-SITE AS OBSERVED IN August 1991

DOMINANT SPECIES *Typha latifolia, Lythrum salicaria, Carex lyngbyei, Agrostis alba*

ASSOCIATED SPECIES *Juncus articulatus, Lythrum salicaria, Alisma plantago-aquatica, Sagittaria latifolia, Bidens cernua, Scirpus validus, Calamagrostis canadensis*

DOCUMENTATION & CONTACTS

Mark Adams. unpubl. documents.
DFO contact: Kevin Conlin, Bruce Clark, Otto Langer

ADDITIONAL COMMENTS

Excellent results have been obtained by "willow wattling" (i.e., successful establishment of riparian willow vegetation) on intertidal islands. Transplanted Lyngby's sedge is being displaced by cat-tail, purple loosestrife and bentgrass.

Historical and compensated habitat area numbers are preliminary estimates. Accurate information on pre-lagoon and post-restoration habitats is currently not available.

CATEGORY	Compensation	SITE NO.	09-004
STATUS	Complete	C.P.R. NO.	8902-0010
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PROJECT NAME	Riverwest Condominiums, Ladner.		
PROPONENT	Canlan Investment Corp.		
LOCATION	Ladner Harbour, 48th Ave. & 47A Str.		
UTM GRID REF.	Easting: 493390	Northing: 5437391	
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IMPACT	Loss of marsh due to dyke reconstruction for housing development.		
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RATIONALE	Stabilization of shoreline for residential development and adjacent marina. Compensation of marsh at 2:1		
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FEATURES	Construction of marsh bench 3m X 145m		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	0	100	0
GAINED	0	0	410	0
NET	0	0	310	0

IMPACT DATE	1989	LAST ON-SITE INSPECTION	Sept. 1992
CONSTR. DATE	1990	MONITORED PERIOD	NIL
PLANT DATE	1990	REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	YES

VEGETATION GROWING ON-SITE AS OBSERVED IN August 1991

DOMINANT SPECIES *Carex lyngbyei* - *Phalaris arundinaceae* - *Scirpus validus*

ASSOCIATED SPECIES *Lythrum salicaria*, *Calamagrostis canadensis*, *Juncus articulatus*

DOCUMENTATION & CONTACTS

Ron Kistriz. unpubl. documents.
DFO contact: Bob McIndoe

ADDITIONAL COMMENTS

CATEGORY	Compensation	SITE NO.	09-005
STATUS	Complete	C.P.R. NO.	8808-0083
<hr/>			
PROJECT NAME	River Road & Admiral Blvd. Compensation Site.		
PROPONENT	Marina Garden Estates Ltd.		
LOCATION	West end of Green Slough at River Rd. & Admiral Blvd.		
UTM GRID REF.	Easting: 494809	Northing: 5439005	
<hr/>			
IMPACT	Loss of habitats due to riprap and sheet piling in Green Slough, and habitat losses due to bridge construction at Admiral Blvd.		
<hr/>			
RATIONALE	Bridge construction. Compensation of 2:1 for marsh, 1:1 for mudflat, 1:1 for riparian, and 1:2 for marsh:mudflat, 15m buffer zone along Green Slough.		
<hr/>			
FEATURES	Creation of marsh, mudflat, and riparian habitat in two blind channels. Activities related to this project are also filed under CPR#8908-0061 and CPR#9107-0061.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	54	54	35
GAINED	0	100	250	80
NET	0	46	196	45

IMPACT DATE	1991	LAST ON-SITE INSPECTION	Sept. 1992
CONSTR. DATE	1991	MONITORED PERIOD	NO
PLANT DATE	1991	REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	YES

VEGETATION GROWING ON-SITE AS OBSERVED IN August 1991

DOMINANT SPECIES *Carex lyngbyei* - *Bidens cernus* - *Alisma plantago-aquatica*

ASSOCIATED SPECIES *Polygonum spp.*, *Lycopus americanus*, *Lythrum salicaria*, *Callitriche stagnalis*, *Elodea canadensis*, *Scirpus validus*, *Sagittaria latifolia*, *Typha latifolia*, *Cornus stolonifera*, *Betula spp.*, *Ribes spp.*

DOCUMENTATION & CONTACTS

Mark Adams. unpubl. documents.
DFO contact: Bruce Clark, Kevin Conlin

ADDITIONAL COMMENTS

An old wooden culvert that had collapsed and was blocking Green Slough was removed to improve tidal flows.

CATEGORY	Restoration	SITE NO.	09-006
STATUS	Complete	C.P.R. NO.	8904-0034
<hr/>			
PROJECT NAME	Clean Marsh And Estuary Project		
PROPONENT	Mr. Mike Ladislaus, 4355 River Road, Ladner		
LOCATION	Ladner Reach area		
UTM GRID REF.	Easting: 492437	Northing: 5437144	

IMPACT Impacts on the marsh are from heavy accumulations of log debris in certain locations. This debris chokes vegetation and reduces marsh productivity.

RATIONALE Based on an unsolicited proposal to clean up log debris in the estuary.

FEATURES Marsh clean-up, and removal of wood debris. The staging area is located on the south west end of the island immediately south of Barber Island.

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	0	0	0
GAINED	0	0	0	0
NET	0	0	0	0

IMPACT DATE	N.A.	LAST ON-SITE INSPECTION	
CONSTR. DATE	N.A.	MONITORED PERIOD	NO
PLANT DATE	N.A.	REQUIREMENT FOR REMEDIAL ACTION	N.A.
		WAS THE>NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	N.A.

VEGETATION GROWING ON-SITE AS OBSERVED IN

**DOMINANT
SPECIES**

**ASSOCIATED
SPECIES**

DOCUMENTATION & CONTACTS

DFO contact: Bob McIndoe

ADDITIONAL COMMENTS

CATEGORY	Compensation	SITE NO.	09-007
STATUS	Incomplete	C.P.R. NO.	8912-0097

PROJECT NAME **Paramount Site, Cannery Channel.**
 PROPONENT Public Works Canada for Small Craft Harbour

LOCATION Steveston Harbour, opposite Paramount Site near Shady Is.
 UTM GRID REF. Easting: 488112 Northing: 5440454

IMPACT The shoreline adjacent to the Steveston Paramount pier #38 was cut and filled in early 1990 to form clean lines and grades. This work resulted in the loss of marsh and mudflat.

RATIONALE Enlargement of mooring area and rip-rap of shoreline. Compensation of 1:2 marsh:mudflat, 2:1 marsh:marsh

FEATURES Also filed under CPR#8805-0060. PWC attempted to create 1,625 sq.m of marsh by placing marsh sods on low intertidal mudflat of Steveston Island. However this effort created only 488 sq. m of marsh.

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	250	750	100
GAINED	0	0	488	0
NET	0	-250	-262	-100

IMPACT DATE	1990	LAST ON-SITE INSPECTION	Sept. 1991
CONSTR. DATE	1990	MONITORED PERIOD	NIL
PLANT DATE	1990	REQUIREMENT FOR REMEDIAL ACTION	YES
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	NO

VEGETATION GROWING ON-SITE AS OBSERVED IN

**DOMINANT
SPECIES**

**ASSOCIATED
SPECIES**

DOCUMENTATION & CONTACTS

Mark Adams. unpubl. documents.
DFO contact: Bruce Clark, Kevin Conlin

ADDITIONAL COMMENTS

During early 1990, PWC undertook a marsh creation project to compensate for works associated with shoreline upgrading adjacent to Steveston Paramount Pier #38.

PWC was required by the ERC to create a total of 1,625 square metres of new intertidal marsh on Steveston Island as compensation.

Sods of *C. lyngbyei* were placed on low intertidal mudflats of Steveston Island within Cannery Channel, south of Pier #38. As of January 17, 1992, only approx. 488 square metres of marsh had become established -- a shortfall of 1,137 square metres of marsh.

Small Craft Harbours has committed to replacing marsh shortfall.

CATEGORY	Compensation	SITE NO.	09-008
STATUS	Incomplete	C.P.R. NO.	9004-0052
<hr/>			
PROJECT NAME	Erosion Protection Wall, Ladner Yacht Club.		
PROPONENT	Ladner Yacht Club		
LOCATION	Ladner Harbour		
UTM GRID REF.	Easting: 493983	Northing: 5437817	

IMPACT Impact on intertidal habitats due to dredging and backfill.

RATIONALE Bank stabilization. Marsh replacement at 2:1.

FEATURES Creation of narrow (1m wide) marsh bench on steep 5m X 145m slope. Unsatisfactory; no evidence of planting.

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	1,047	143	0
GAINED	0	0	0	0
NET	0	-1,047	-143	0

IMPACT DATE	1990	LAST ON-SITE INSPECTION	August 1991
CONSTR. DATE	1991	MONITORED PERIOD	NO
PLANT DATE		REQUIREMENT FOR REMEDIAL ACTION	YES
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	NO

VEGETATION GROWING ON-SITE AS OBSERVED IN August 1991

**DOMINANT
SPECIES**

**ASSOCIATED
SPECIES**

DOCUMENTATION & CONTACTS

Gary Williams, pers. comm.
DFO contact: Bob McIndoe

ADDITIONAL COMMENTS

Habitat compensation was to have included 810 sq.m. of marsh. However, due to a dispute over the property line and a boat ramp (125 sq.m.), all or part of the disputed area would have to be subtracted from the marsh compensation area and substituted with up to 145 m of riparian.

CATEGORY	Creation	SITE NO.	09-009
STATUS	Complete	C.P.R. NO.	9007-0082
<hr/>			
PROJECT NAME	Marina Garden's - Stormwater Treatment System		
PROPONENT	Marine Garden Estates Ltd.		
LOCATION	Ladner Marsh Wildlife Management Area		
UTM GRID REF.	Easting: 494147	Northing: 5439618	
<hr/>			
IMPACT	There was no habitat loss or alienation; therefore no compensation was required.		
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RATIONALE	The stormwater treatment system was designed and constructed to mitigate the impact of stormwater discharges in the Fraser River Estuary		
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FEATURES	The treatment system consists of upland ponds and basins for primary treatment and a final marsh basin for polishing.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0		11,750	0
GAINED	9,500	1,500	11,920	650
NET	9,500	1,500	170	650

IMPACT DATE	N.A.	LAST ON-SITE INSPECTION	Sept. 1992
CONSTR. DATE	1992	MONITORED PERIOD	NO
PLANT DATE	1992	REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	N.A.

VEGETATION GROWING ON-SITE AS OBSERVED IN

**DOMINANT
SPECIES**

**ASSOCIATED
SPECIES**

DOCUMENTATION & CONTACTS

Mark Adams. unpubl. documents.
MOELP contact: Jack Evans

ADDITIONAL COMMENTS

There are two habitat projects associated with the "Ladner Marsh Sandfill Site Occupation Agreement" between BC Environment and Captains Cove Marina which is developing a large residential subdivision, golf course and marina complex on the lands east of Ferry Road. The habitat projects as of January 1993 are as follows:

1. Stormwater treatment channels on land administered by B.C. Environment west of Ferry Road. (CPR#9007-0082). Habitat areas were restored from a degraded area of upland; habitat areas gained include mudflat, marsh and riparian as indicated in the record.
2. Flow connections between Green Slough and Ladner Reach and between the Ladner and Green Slough remnants in Ladner marsh. (CPR#9107-0061). Habitat created includes a 950mX10m slough (shown as subtidal area on the balance sheet at the expense of 11,750 sq.m. of high marsh).

CATEGORY	Restoration	SITE NO.	10-001
STATUS	Complete	C.P.R. NO.	1-N.A.
<hr/>			
PROJECT NAME	Tilbury Slough Restoration Project		
PROPOSER	Department Of Fisheries And Oceans		
LOCATION	South Arm, south bank, Tilbury Slough		
UTM GRID REF.	Easting: 497170	Northing: 5442201	

IMPACT A dyke constructed in the late 1800's removed ca. 5 ha of marsh habitat from the estuary.

RATIONALE The restoration project improved the tidal circulation and access by juvenile salmon to a dyked and abandoned marsh area.

FEATURES Breaching of remnant dyke and creation of drainage channels. A shear boom was installed at mouth of slough.

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	0	0	0
GAINED	0	0	0	0
NET	0	0	0	0

IMPACT DATE	1985	LAST ON-SITE INSPECTION	August 1991
CONSTR. DATE	1985	MONITORED PERIOD	1988
PLANT DATE	N.A.	REQUIREMENT FOR REMEDIAL ACTION	YES
		WAS THE>NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	N.A.

VEGETATION GROWING ON-SITE AS OBSERVED IN August 1991

DOMINANT SPECIES *Typha latifolia* - *Carex lyngbyei*

ASSOCIATED SPECIES *Lythrum salicaria*, *Iris pseudacorus*, *Lysichitum americanum*

DOCUMENTATION & CONTACTS

Macdonald, J.S., R.U. Kistritz, and M. Farrell. 1990. An examination of the effects of slough habitat reclamation in the Lower Fraser River, B.C.: Can. Tech. Rept. Fish. & Aquat. Sci. 1731: 59 p.

DFO contact: Kevin Conlin, Steve Macfarlane

ADDITIONAL COMMENTS

The diked portion of Tilbury Slough was partially breached prior to restoration activity. Therefore, tidal circulation was fully restored and overall fish access and detrital and fish food export was enhanced.

There are no numbers shown in the habitat balance sheet since most of the area was enhanced rather than restored.

The shear boom at the slough opening needs to be replaced and log debris removed from the slough.

Although considered restoration, the works were funded by money made available by the B.C. Development Corp. to compensate for habitat they filled in along Tilbury Slough some 10 years earlier.

CATEGORY	Compensation	SITE NO.	10-002
STATUS	Complete	C.P.R. NO.	1-N.A.
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PROJECT NAME	Fraser Richmond Landfill, Compensation Site.		
PROPONENT	Fraser River Harbour Commission		
LOCATION	End of Nelson (Dyke) Road, Richmond.		
UTM GRID REF.	Easting: 498649 Northing: 5444254		
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IMPACT	Loss of marsh, riparian and mudflat habitat in connection to bank stabilization work for Richmond Landfill Site.		
<hr/>			
RATIONALE	Fill for future port development. Habitat compensation was to replace marsh at a 1:1 ratio.		
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FEATURES	Marsh lagoon with irregular elevations protected by a riprap berm.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	0	5,000	665
GAINED	0	0	10,000	0
NET	0	0	5,000	-665

IMPACT DATE	1979	LAST ON-SITE INSPECTION	Sept. 1991
CONSTR. DATE	1979	MONITORED PERIOD	NO
PLANT DATE	1988	REQUIREMENT FOR REMEDIAL ACTION	YES
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	YES

VEGETATION GROWING ON-SITE AS OBSERVED IN September 1991

DOMINANT SPECIES *Juncus articulatus* - *Carex lyngbyei* - *Typha latifolia*

ASSOCIATED SPECIES *Lythrum salicaria*, *Lycopus americanus*, *Boltonia asteroides*, *Scirpus cyperoides*, *Myrica gale*, *Cirsium arvense*, *Calamagrostis canadensis*, *Potentilla pacifica*, *Galium trifidum*, *Bidens cernua*, *Alisma plantago-aquatica*, *Populus trichocarpus*

DOCUMENTATION & CONTACTS

Williams, G.L. 1987. Preliminary design of habitat compensation for Fraser Richmond Terminal, Richmond B.C. Rept. prep. for FRHC.
DFO contact: Otto Langer, Kevin Conlin

ADDITIONAL COMMENTS

Design specifications included a rock riprap jetty or wall around the marsh area. Openings were provided to ensure fish access and nutrient and fish food flushing. Large tires were used in the openings as debris barriers. The debris barriers need to be improved to function more effectively.

Originally ca. 2 ha of marsh/riparian habitat was lost by this port development. The matter went to court but litigations did not reverse the losses. The works described here relate to after the fact compensation relative to remnant habitat areas outside the major wetland areas filled in 1979.

CATEGORY	Compensation	SITE NO.	10-003
STATUS	Complete	C.P.R. NO.	8807-0073
<hr/>			
PROJECT NAME	Linwood Homes Ltd., Compensation Site.		
PROPONENT	Linwood Homes Ltd.		
LOCATION	Fraser River, south bank, opposite 8250 River Road (Delta)		
UTM GRID REF.	Easting: 500559 Northing: 5444014		
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IMPACT	Loss of intertidal habitat due to road widening, bank protection, and fill.		
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RATIONALE	Widening of approach road. Marsh replacement at 2:1.		
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FEATURES	Very small and low marsh bench. Site should be replanted and better protected.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	300	50	0
GAINED	0	120	180	0
NET	0	-180	130	0

IMPACT DATE	1989	LAST ON-SITE INSPECTION	August 1991
CONSTR. DATE	1989	MONITORED PERIOD	NO
PLANT DATE	1990	REQUIREMENT FOR REMEDIAL ACTION	YES
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	YES

VEGETATION GROWING ON-SITE AS OBSERVED IN

**DOMINANT
SPECIES**

**ASSOCIATED
SPECIES**

DOCUMENTATION & CONTACTS

DFO contact: Bruce Clark

ADDITIONAL COMMENTS

Several of the original sedge transplants have regenerated and rushes (*J. articulatus*) are colonizing the bare substrate.

However, the marsh vegetation is under continuous stress due to grounding of logs. The log storage guidelines need to be enforced at this site.

CATEGORY	Compensation	SITE NO.	11-001
STATUS	Complete	C.P.R. NO.	N.A.

PROJECT NAME **Patrick Is. Habitat Compensation**
 PROPONENT B.C. Ministry Of Transportation & Highways

LOCATION Annacis Channel, Patrick Island
 UTM GRID REF. Easting: 503424 Northing: 5446744

IMPACT Foreshore habitat was lost due to construction of Annacis Channel Swing Bridge.

RATIONALE Productive rearing and feeding habitat for juvenile salmon, equal to or exceeding that lost due to construction was to be developed.

FEATURES Intertidal and subtidal embayment excavated into the shoreline of Patrick Island. A shear boom was installed across the entrance of the embayment.

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	0	0	120
GAINED	16,000	2,200	2,150	120
NET	16,000	2,200	2,150	0

IMPACT DATE	1984	LAST ON-SITE INSPECTION	Sept. 1992
CONSTR. DATE	1984	MONITORED PERIOD	1986-88
PLANT DATE	1985	REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE>NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	YES

VEGETATION GROWING ON-SITE AS OBSERVED IN

**DOMINANT
SPECIES**

**ASSOCIATED
SPECIES**

DOCUMENTATION & CONTACTS

Anne Moody, unpubl. documents.
DFO contact: Bruce Clark

ADDITIONAL COMMENTS

The habitat compensation agreement was for a 1:1 replacement of marsh plus credit for clean-up efforts.

The requirement was for 1,707 sq.m. of marsh and 225 m of riparian habitat to be built. To date, the as-built area is 1,866 sq.m. marsh and 171 m of riparian at the foot of Carter Str. A 50% credit was given for cleaning up 564 sq.m. of marsh.

This site is part of a project undertaken by Dr. C.D. Levings under the Fraser River Action Plan to assess the ecology of compensation marshes in comparison to natural marshes.

CATEGORY	Compensation	SITE NO.	11-004
STATUS	Complete	C.P.R. NO.	8901-0008
<hr/>			
PROJECT NAME	Grosvenor Habitat Park, S. End of Annacis Is.		
PROPONENT	Grosvenor International Ltd.		
LOCATION	Annacis Island, south end, Lot 350, Plan 84718		
UTM GRID REF.	Easting: 501443	Northing: 5445190	
<hr/>			
IMPACT	Landfill alienated some 700m of tidal ditch behind the dyke, accessed by fry via a derelict flapgate.		
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RATIONALE	Retain 300m of original tidal ditch; construct 500m of new ditch; width, 6m at high tide, 3m at low tide; channel bottom at -1.0 Geod.; tidal flushing		
<hr/>			
FEATURES	Development of channels for fish habitat.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	3,500	0	0
GAINED	0	5,016	7,500	0
NET	0	1,516	7,500	0

IMPACT DATE	N.A.	LAST ON-SITE INSPECTION	Sept. 1992
CONSTR. DATE	1989	MONITORED PERIOD	NO
PLANT DATE	1989	REQUIREMENT FOR REMEDIAL ACTION	YES
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	YES

VEGETATION GROWING ON-SITE AS OBSERVED IN August 1991

DOMINANT SPECIES *Scirpus cyperinus* - *Typha latifolia*

ASSOCIATED SPECIES *Impatiens capensis*, *Spiraea douglasii*, *Alnus rubra*, *Calamagrostis canadensis*, *Bidens cernua*,
Agropyron repens, *Sagittaria latifolia*, *Myosotis scorpioides*, *Lythrum salicaria*

DOCUMENTATION & CONTACTS

Bill Field (DFO), unpub. documents.
DFO contact: Kevin Conlin, Bill Field

ADDITIONAL COMMENTS

The outlet of the channel system needs to be improved by providing an additional outlet opening.

CATEGORY	Compensation	SITE NO.	11-005
STATUS	Incomplete	C.P.R. NO.	8905-0042
<hr/>			
PROJECT NAME	Storm Sewer Outfall #11, Annacis Channel.		
PROPONENT	Annacis Properties Ltd.		
LOCATION	Annacis Island, north-west shore		
UTM GRID REF.	Easting: 501712	Northing: 5445460	
<hr/>			
IMPACT	Loss of mud/sandflat due to excavation and riprap.		
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RATIONALE	Storm drain outfall. Planting at 1:2 to replace mudflat.		
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FEATURES	Upon inspection, there was no evidence of any compensation involving marsh or riparian vegetation as was requested.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	240	0	0
GAINED	0	0	0	0
NET	0	-240	0	0

IMPACT DATE	1989	LAST ON-SITE INSPECTION	August 1991
CONSTR. DATE	1989	MONITORED PERIOD	NO
PLANT DATE	1990	REQUIREMENT FOR REMEDIAL ACTION	YES
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	NO

VEGETATION GROWING ON-SITE AS OBSERVED IN

**DOMINANT
SPECIES**

**ASSOCIATED
SPECIES**

DOCUMENTATION & CONTACTS

DFO contact: Bob McIndoe

ADDITIONAL COMMENTS

The compensation site needs to be replanted.

CATEGORY	Restoration	SITE NO.	11-006
STATUS	Complete	C.P.R. NO.	8911-0093

PROJECT NAME **Shoreline Clean-up, Annacis Island.**

PROPOSER William J. Deboft

LOCATION Annacis Island shoreline, near south end of Purfleet Point

UTM GRID REF. Easting: 501670 Northing: 5445096

IMPACT It is assumed that the marsh restoration resulted in a 50% increase in marsh growth.

RATIONALE

FEATURES Shoreline Clean-up

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	0	10,500	0
GAINED	0	0	10,500	0
NET	0	0	0	0

IMPACT DATE

CONSTR. DATE 1989

PLANT DATE

LAST ON-SITE INSPECTION

MONITORED PERIOD

REQUIREMENT FOR
REMEDIAL ACTION NO

WAS THE>NNL GUIDELINE
SUCCESSFULLY ACHIEVED? N.A.

VEGETATION GROWING ON-SITE AS OBSERVED IN April 1993

DOMINANT SPECIES *Juncus articulatus, Phalaris arundinacea*

ASSOCIATED SPECIES

DOCUMENTATION & CONTACTS

Alan Domaas, FRHC files.

ADDITIONAL COMMENTS

On the basis of a site inspection on April 8, 1993 it was evident that the marsh bench was sparsely vegetated. The patchy marsh growth covered approximately 20-25% of the lower bench margin. Rock, sand and gravel accretion on the upper one-half of the bench was limiting the establishment of new growth. Of the total bench area (2400 sq. m.) ca. 25% or 600 sq. m. was covered by marsh vegetation. The remaining area consisted of sand and gravel substrate.

CATEGORY	Compensation	SITE NO.	12-001
STATUS	Complete	C.P.R. NO.	N.A.
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PROJECT NAME	Gunderson Slough Habitat Bench		
PROPONENT	Fraser River Harbour Commission		
LOCATION	Head of Gunderson Slough		
UTM GRID REF.	Easting: 506245	Northing: 5447035	
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IMPACT	Loss of marsh and mudflat due to shoreline protection work along north shore of slough.		
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RATIONALE	Compensation was for losses of marsh at a 1:1 ratio.		
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FEATURES	A marsh bench was built with with riprap facing.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	0	625	0
GAINED	0	0	625	0
NET	0	0	0	0

IMPACT DATE	1982	LAST ON-SITE INSPECTION	August 1991
CONSTR. DATE	1983	MONITORED PERIOD	NIL
PLANT DATE	1983	REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	YES

VEGETATION GROWING ON-SITE AS OBSERVED IN August 1991

DOMINANT SPECIES *Typha latifolia* - *Lythrum salicaria*

ASSOCIATED SPECIES *Galium spp.*, *Juncus effusus*, *Myosotis scorpioides*, *Epilobium watsonii*, *Iris pseudacorus*,
Polygonum spp., *Mentha arvensis*, *Bidens cernua*, *Juncus articulatus*, *Alisma*
plantago-aquatica, *Carex lyngbyei*, *Phalaris arundinacea*

DOCUMENTATION & CONTACTS

DFO contact: Bob McIndoe

ADDITIONAL COMMENTS

CATEGORY	Compensation	SITE NO.	12-002
STATUS	Complete	C.P.R. NO.	8610-0067
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PROJECT NAME	Vito's Compensation Site.		
PROPONENT	Vito Steel Boat & Barge Construction Facility Ltd.		
LOCATION	Fraser River, south side, 9425 River Road.		
UTM GRID REF.	Easting: 503127	Northing: 5444368	
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IMPACT	Alienation of intertidal area due to retaining wall construction and fill.		
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RATIONALE	Marsh bench (80 sq.m) to be constructed for original CPR # 8610-0067.		
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FEATURES	Construction of 2m X 40m marsh bench; however nothing remains as of inspection in September 1991. The compensation site was swept away by river currents.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	80	0	0
GAINED	0	0	0	0
NET	0	-80	0	0

IMPACT DATE	1987	LAST ON-SITE INSPECTION	Sept. 1991
CONSTR. DATE	1987	MONITORED PERIOD	NIL
PLANT DATE		REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	NO

VEGETATION GROWING ON-SITE AS OBSERVED IN

**DOMINANT
SPECIES**

**ASSOCIATED
SPECIES**

DOCUMENTATION & CONTACTS

DFO contact: Marissa Byrne

ADDITIONAL COMMENTS

CATEGORY	Compensation	SITE NO.	12-003
STATUS	Complete	C.P.R. NO.	8705-0047
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PROJECT NAME	Burlington Northern RR, Gunderson Slough.		
PROPONENT	Burlington Northern Railroad		
LOCATION	Entrance to Gunderson Slough, below RR trestle.		
UTM GRID REF.	Easting: 505803	Northing: 5446210	
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IMPACT	Loss of habitat due to trestle replacement.		
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RATIONALE	Railway trestle construction. Habitat replacement for mud:marsh at 1:2, marsh:marsh at 2:1.		
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FEATURES	Narrow (1.5m to 3m wide) marsh bench protected by riprap located below railway.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	1,450	164	0
GAINED	0	0	500	0
NET	0	-1,450	336	0

IMPACT DATE	1987	LAST ON-SITE INSPECTION	Sept. 1991
CONSTR. DATE	1987	MONITORED PERIOD	NIL
PLANT DATE	1987	REQUIREMENT FOR REMEDIAL ACTION	YES
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	NO

VEGETATION GROWING ON-SITE AS OBSERVED IN September 1991

DOMINANT SPECIES *Juncus articulatus - Phalaris arundinacea*

ASSOCIATED SPECIES *Epilobium watsonii, Polygonum lapathifolium, Bidens cernua, Potentilla pacifica, Impatiens capensis.*

DOCUMENTATION & CONTACTS

Norecol Environmental Consultants Ltd. 1987. Burlington Northern Trestle at Gunderson Slough. Rept. subm. to Thurber Consultants Ltd.
DFO contact: Bob McIndoe

ADDITIONAL COMMENTS

The as-built marsh bench is approximately 1,000 sq.m. short of the required 1,445 sq.m. needed for compensation. There is no indication of any other marsh compensation work adjacent to the trestle.

CATEGORY	Compensation	SITE NO.	12-004
STATUS	Complete	C.P.R. NO.	9111-0115
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PROJECT NAME	Alex Fraser Bridge, South Sand Island		
PROPONENT	Ministry of Transportation & Highways		
LOCATION	South Arm, south pier of bridge, off River Road in Delta		
UTM GRID REF.	Easting: 504369	Northing: 5444883	

IMPACT Original impacts included losses of subtidal habitat, mudflat and small ribbon marshes within the area occupied by the bridge abutments (sand islands).

RATIONALE In response to remaining habitat compensation obligations of the Ministry of Transportation & Highways in connection to the Annacis Crossing Project.

FEATURES The compensation site consists of a basin excavated out of the sand island that serves as the bridge abutment. The basin has a single downstream opening.

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	20,000	350	275	250
GAINED	<u>0</u>	<u>0</u>	<u>2,000</u>	<u>0</u>
NET	-20,000	-350	1,725	-250

IMPACT DATE	1984	LAST ON-SITE INSPECTION	Sept. 1992
CONSTR. DATE	1992	MONITORED PERIOD	
PLANT DATE	1992	REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE>NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	YES

VEGETATION GROWING ON-SITE AS OBSERVED IN

**DOMINANT
SPECIES**

**ASSOCIATED
SPECIES**

DOCUMENTATION & CONTACTS

Kistriz Consultants Ltd. 1985. Annacis Bridge Crossing Project: Final Report on Environmental Studies of Water Quality and Aquatic Habitats. Rept. subm. to Ministry of Transportation and Highways.
Paul Harder & Assoc. unpubl. documents.
DFO contact: Bob McIndoe

ADDITIONAL COMMENTS

CATEGORY	Compensation	SITE NO.	13-001
STATUS	Complete	C.P.R. NO.	8611-0076
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PROJECT NAME	Westminster Quay, Phase 1, Compensation.		
PROPONENT	First Capital City Development Co. Ltd.		
LOCATION	New Westminster waterfront, next to wooden RR trestle.		
UTM GRID REF.	Easting: 505852 Northing: 5449269		
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IMPACT	Foreshore infilling and riprap of 3,150 sq.m. at the end of Fifth Street Basin.		
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RATIONALE	Marsh bench created on foreshore by pulling back old bank and creating a rock riprap basin lined with filter cloth.		
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FEATURES	Marsh bench, 4m X 48m, incorporated into riprap dyke. Invasion by shrub species evident, suggesting high elevation.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	3,150	0	0
GAINED	0	0	192	0
NET	0	-3,150	192	0

IMPACT DATE	1984	LAST ON-SITE INSPECTION	Sept. 1992
CONSTR. DATE	1987	MONITORED PERIOD	
PLANT DATE	1988	REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	YES

VEGETATION GROWING ON-SITE AS OBSERVED IN August 1991

DOMINANT SPECIES *Juncus triglumis - Carex lyngbyei - Scirpus cyperinus*

ASSOCIATED SPECIES *Lythrum salicaria, Epilobium watsonii, Typha latifolia, Sium suave, Salix lasiandra, Alnus rubra, Potentill pacifica, Agropyron repens, Solidago missouriensis, Lycopus americanus, Trifolium repens, Triglochin maritimum, Alisma plantago-aquatica*

DOCUMENTATION & CONTACTS

Mark Adams. unpubl. documents.
DFO contact: Kevin Conlin, Marissa Byrne

ADDITIONAL COMMENTS

Comensation was provided well after the loss, and at a greatly reduced ratio compared to many other sites.

CATEGORY	Compensation	SITE NO.	13-002
STATUS	Incomplete	C.P.R. NO.	8710-0091

PROJECT NAME **Timberland Basin**
 PROPONENT Fraser River Harbour Commission

LOCATION Fraser River, south bank, opposite New Westminster
 UTM GRID REF. Easting: 507297 Northing: 5449463

IMPACT Alteration of habitats due to dredging and training wall reconstruction activities, as well as proposed development of port facility.

RATIONALE This site is a designated "habitat bank" for the Fraser River Harbour Commission. It will be used to compensate for future habitat losses in the area.

FEATURES Construction of 30,000 sq.m habitat compensation site. Vegetation planting planned for 1992. Site will be monitored as part of a research project.

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	16,000	0	0	25
GAINED	<u>0</u>	<u>16,000</u>	<u>0</u>	<u>0</u>
NET	-16,000	16,000	0	-25

IMPACT DATE		LAST ON-SITE INSPECTION	Sept. 1992
CONSTR. DATE	1991	MONITORED PERIOD	
PLANT DATE		REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE>NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	N.A.

VEGETATION GROWING ON-SITE AS OBSERVED IN

**DOMINANT
SPECIES**

**ASSOCIATED
SPECIES**

DOCUMENTATION & CONTACTS

Kistritz Consultants Ltd. 1986. Environmental mapping of aquatic shoreline habitats in the
Timberland Basin area. Rept. subm. to Fraser River Harbour Commission.

Also: Mark Adams. unpubl. documents.

DFO contact: Kevin Conlin, Bob McIndoe, Steve Macfarlane

PWC contact: Alex Fakidas (provided habitat area number)

ADDITIONAL COMMENTS

This Habitat Bank is intended to compensate for habitat losses from future developments in
nearby locations. As such, the net gain in habitat presently shown will gradually be offset by
losses attributable to various development projects.

CATEGORY	Compensation	SITE NO.	13-003
STATUS	Complete	C.P.R. NO.	9003-0038

PROJECT NAME **Port Mann Log Sort, Compensation Site.**
 PROPONENT Fletcher Challenge Canada

LOCATION
 UTM GRID REF. Easting: 512080 Northing: 5451972

IMPACT Expansion and revtment of dryland sort area.

RATIONALE Foreshore bank stabilization in conjunction with compensation.

FEATURES Marsh bench, extension of existing marsh, protected by low piles and cribbing. Very sparsely vegetated.

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	501	0	0
GAINED	0	0	627	0
NET	0	-501	627	0

IMPACT DATE	1990	LAST ON-SITE INSPECTION	Sept. 1991
CONSTR. DATE	1991	MONITORED PERIOD	NIL
PLANT DATE	1991	REQUIREMENT FOR REMEDIAL ACTION	YES
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	YES

VEGETATION GROWING ON-SITE AS OBSERVED IN September 1991

DOMINANT SPECIES *Juncus acuminatus* - *Carex lyngbyei*

ASSOCIATED SPECIES *Typha latifolia*, *Myosotis scorpioides*, *Veronica americana*, *Sagittaria latifolia*, *Polygonum spp.*, *Lythrum salicaria*, *Callitriche stagnalis*, *Scirpus cernuus*, *Gnaphalium uliginosum*, *Bidens cernua*, *Alisma plantago-aquatica*.

DOCUMENTATION & CONTACTS

Gary Williams. pers. comm.
DFO contact: Bob McIndoe

ADDITIONAL COMMENTS

This bench was likely not planted with marsh vegetation, but gradually became naturally colonized. This would explain the sparse marsh growth noted during the on-site inspection. There is also a considerable amount of erosion occurring behind the log retaining wall. This is probably due to a lack of geofabric required to prevent sediment erosion in marsh benches.

This site is part of a project undertaken by Dr. C.D. Levings under the Fraser River Action Plan to assess the ecology of compensation marshes in comparison to natural marshes. The bench requires some remedial planting as well as protection from further erosion.

CATEGORY	Compensation	SITE NO.	14-001
STATUS	Complete	C.P.R. NO.	1-N.A.
<hr/>			
PROJECT NAME	C N Railway, Twin Tracking, West Surrey Bend.		
PROPONENT	C N Railway		
LOCATION	Western end of Surrey Bend where RR tracks crosses a culvert		
UTM GRID REF.	Easting: 517288 Northing: 5450866		

IMPACT Loss of some intertidal and riparian habitat due to widening of track bed in the Thornton Yard, and subsequent construction of habitat area. Also, some losses of stream habitat.

RATIONALE Compensation was based on a 1:1 replacement ratio.

FEATURES Sidecast material from RR construction was lowered to intertidal elevation and planted with marsh vegetation. High marsh (alder and grasses) was lost and converted to a lower elevation marsh.

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	500	4,000	100
GAINED	0	0	4,000	0
NET	0	-500	0	-100

IMPACT DATE	1985	LAST ON-SITE INSPECTION	Sept. 1991
CONSTR. DATE	1988	MONITORED PERIOD	NIL
PLANT DATE	1988	REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	YES

VEGETATION GROWING ON-SITE AS OBSERVED IN September 1991

DOMINANT SPECIES *Typha latifolia - Juncus effusus.*

ASSOCIATED SPECIES *Lythrum salicaria, Veronica americana, Leersia oryzoides, Calamagrostis canadensis, Bidens cernua, Scripus cyperoides, Salix lasiandra, Sagittaria latifolia, Polygonum lapathifolium, Juncus acuminatus.*

DOCUMENTATION & CONTACTS

Anne Moody. unpubl. documents.
DFO contact: Otto Langer, Kevin Conlin, Brian Dane

ADDITIONAL COMMENTS

This compensation marsh was constructed by lowering the elevation in the riparian zone parallel to the CN track along a distance of approximately 100 m.

This site is part of a project undertaken by Dr. C.D. Levings under the Fraser River Action Plan to assess the ecology of compensation marshes in comparison to natural marshes.

CATEGORY	Compensation	SITE NO.	14-002
STATUS	Complete	C.P.R. NO.	8610-0066
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PROJECT NAME	C N Intermodal Yard, Surrey Bend.		
PROPONENT	C N Railway		
LOCATION	Surrey Bend where central creek drainage crosses RR tracks.		
UTM GRID REF.	Easting: 518581	Northing: 5450093	

IMPACT Infilling of wetland habitat along CNR track. An estimated 141,000 sq.m of wetland was lost or alienated. Entire area of 400,000 sq.m. could have been considered wetland.

RATIONALE Ratio of 1.3:1 was requested. A \$600,000 cash settlement was spent on acquiring Kirkland Island and Widgeon Marsh Park Reserve for wildlife purposes.

FEATURES Compensation features include creek enhancement for Coho spawning south of tracks, a pond construction north of tracks, and culverts underneath the railway bed.

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	0	0	718
GAINED	0	0	0	0
NET	0	0	0	-718

IMPACT DATE	1989	LAST ON-SITE INSPECTION	May 1991
CONSTR. DATE	1990	MONITORED PERIOD	1990-92
PLANT DATE		REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	NO

VEGETATION GROWING ON-SITE AS OBSERVED IN

**DOMINANT
SPECIES**

**ASSOCIATED
SPECIES**

DOCUMENTATION & CONTACTS

Lister, D.B. & Assoc. 1987. CN Intermodal Yard Project: Assessment of effects on salmonid fish habitat. Report prep. for CN Rail, Edmonton.

Kistriz, R.U. et.al. 1992. An Ecological Study of Surrey Bend. FREMP and the District of Surrey.

Levings, C.D., T.R. Whitehouse, and D. Boyle. 1993. Juvenile salmon use of food use in transitional land-

ADDITIONAL COMMENTS

The 14.1 ha of wetland habitat lost to the CN Transmodal Yard consisted of Coniferous Hardwood Forest (44%), Birch Woodland (25%), Hardhack Thicket (25%) and Bog (6%). The Hardhack Thicket was the wettest area, closely connected to the Fraser River and accessible to juvenile fish through a network of creeks and beaver ponds. As such the Habitat Balance Sheet includes only 25% of the total loss (35,250 sq.m.) in the riparian category. As a contiguous block, this area's perimeter would have been 718 m. This number serves as a rough indicator of riparian loss for the purpose of the balance sheet, based on the vegetation map of Surrey Bend prepared by Kistriz et.al. 1992.. However the remaining balance sheet cannot be properly completed due to the difficulty of quantifying what was actual fish habitat in this swamp complex.

CATEGORY	Compensation	SITE NO.	14-003
STATUS	Incomplete	C.P.R. NO.	8701-0005
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PROJECT NAME	Marine Way Industries, Port Hammond		
PROPONENT	Stave River Lumber Co. Ltd.		
LOCATION	Fraser River near Port Hammond.		
UTM GRID REF.	Easting: 523948	Northing: 5449531	
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IMPACT	Loss of habitat due to filling in of embayment along riverine foreshore.		
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RATIONALE	Although the lost habitat was of low quality, its productive capacity was to be compensated with a marsh bench and plantings of riparian vegetation.		
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FEATURES	Compensation required the development of a riparian zone, 2 to 3 m wide and 92 m long. This work has not been completed.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	7,813	0	0
GAINED	0	0	0	0
NET	0	-7,813	0	0

IMPACT DATE	LAST ON-SITE INSPECTION	Sept. 1991
CONSTR. DATE	MONITORED PERIOD	
PLANT DATE	REQUIREMENT FOR REMEDIAL ACTION	YES
	WAS THE>NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	NO

VEGETATION GROWING ON-SITE AS OBSERVED IN

**DOMINANT
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SPECIES**

DOCUMENTATION & CONTACTS

DFO contact: Marissa Byrne

ADDITIONAL COMMENTS

The filled embayment was originally dredged from upland to create a marina. Once the site was occupied by a sawmill, the embayment was used for sorting logs and it became degraded with wood debris. When the log sort was no longer required, it was filled to create a storage yard.

Based on the PWC Base Plan No. 53 (Scale, 1:2,500), the size of the embayment prior to filling was 7.813 sq.m.

CATEGORY	Compensation	SITE NO.	14-004
STATUS	Complete	C.P.R. NO.	8702-0015
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PROJECT NAME	Miller Contracting, Compensation, Parsons Channel.		
PROponent	Miller Contracting Ltd.		
LOCATION	East end of Parsons Channel		
UTM GRID REF.	Easting: 524151	Northing: 5448484	
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IMPACT	Alienation of 2,500 sq.m of mudflat by inshore installation of four drydock sections. Mudflat also affected by dredging, railbed, and other rail construction activities.		
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RATIONALE	Compensation for alienated mudflat area.		
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FEATURES	Marsh creation on marsh bench (50x20m) and new fill faced with riprap. This compensation is also applicable to CPR#8707-0070.		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	0	2,500	0	0
GAINED	0	0	1,000	0
NET	0	-2,500	1,000	0

IMPACT DATE	1986	LAST ON-SITE INSPECTION	Sept. 1992
CONSTR. DATE	1986	MONITORED PERIOD	
PLANT DATE	1992	REQUIREMENT FOR REMEDIAL ACTION	NO
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?	YES

VEGETATION GROWING ON-SITE AS OBSERVED IN September 1992

DOMINANT SPECIES *Typha latifolia, Juncus articulatus*

ASSOCIATED SPECIES *Bidens cernua, Myosotis scorpioides, Veronica americana*

DOCUMENTATION & CONTACTS

Mark Adams. unpubl. documents.
DFO contact: Bob McIndoe

ADDITIONAL COMMENTS

CATEGORY	Compensation	SITE NO.	14-005
STATUS	Complete	C.P.R. NO.	9002-0020
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PROJECT NAME	S & R Compensation Site, Barnston Island.		
PROPOSER	S & R Sawmills		
LOCATION	Barnston Island, south shore.		
UTM GRID REF.	Easting: 522857	Northing: 5448056	
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IMPACT	Loss of riparian vegetation.		
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RATIONALE			
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FEATURES	Riparian planting (Cottonwood trees) undertaken on south shore of Barnston Island (Indian Reserve #3).		

HABITAT BALANCE SHEET

	SUBTIDAL sq. m.	MUD/SANDFLAT sq. m.	MARSH sq. m.	RIPARIAN m.
LOST	_____	_____	_____	_____
GAINED	_____	_____	_____	_____
NET	_____	_____	_____	_____
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IMPACT DATE		LAST ON-SITE INSPECTION	Sept. 1991	
CONSTR. DATE		MONITORED PERIOD		
PLANT DATE	1990	REQUIREMENT FOR REMEDIAL ACTION		
		WAS THE NNL GUIDELINE SUCCESSFULLY ACHIEVED ?		

VEGETATION GROWING ON-SITE AS OBSERVED IN

**DOMINANT
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DOCUMENTATION & CONTACTS

Mark Adams. unpubl. documents.
DFO contact: Bob McIndoe, Kevin Conlin

ADDITIONAL COMMENTS
