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LOGGING AND THE NEAR-SHORE MARINE ENVIRONMENT AT ONEPUA BAY, MARLBOROUGH SOUNDS

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Figure 1 - The main processing landing and foreshore below the logged sub-catchment, March 1992

ABSTRACT

Annual surveys of the coastal seabed habitats below logged and unlogged sub-catchments (1992 to 1995), indicated that changes observed below the logged sub-catchment could not be attributed to logging. Significant differences (P<0.05) in proportions of fine sediments, and the numbers and types of marine life were attributed to natural variation and/or storm-induced sedimentation rather than logging activities. The flushing effect of wave and tidal action was credited with preventing the accumulation of fine sediments, and associated impacts, on the near-shore seabed below the logged sub-catchment. Increased sedimentation within the central Onepua Bay region was not detectable. However, long-term trends cannot be ruled out without further monitoring.

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INTRODUCTION

Protection of the marine environment is an important objective for logging operations in the Marlborough Sounds. In particular, reducing soil erosion and associated sedimentation during and after logging is important because of the potential to adversely affect many of the commercial and recreational activities in the sounds.

With the projected increase in logging in the sounds over the next five years (Turland, Wakelin and Lane 1993), there is a need to develop and test environmentally sensitive logging systems or techniques. Accordingly, this study was performed to quantify the effects of one logging operation on the near-shore marine environment within Onepua Bay (Figure 1).

In a similar study, Johnston, Mace and Laffan (1981) measured the effects of logging at Farnham Forest, Queen Charlotte Sound. Erosion of skid trails contributed to fine sediment deposition below the logged areas. This contrasted with deposition below the unlogged areas where coarse sand sediments dominated.

This report describes the logging operation within Onepua Bay, and summarises the major findings of three years of marine monitoring.

ACKNOWLEDGMENTS

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Site Description

Located 18 km northeast of Picton on the southern side of Tory Channel, Onepua Bay drains a largely forested catchment. The bay is narrow (0.5 to 1 km wide) and generally shallow (<20 m depth), extending eight kilometres southeast from Tory Channel (Figure 2). The central Onepua Bay region traps fine sediment derived from land erosion due to the presence of a shallow lip at the head of the bay.

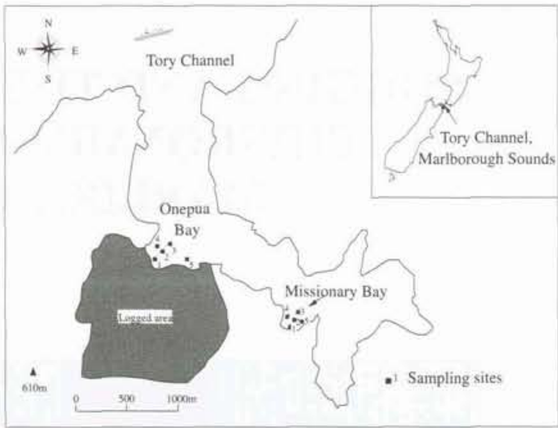

Figure 2 - Location map

Approximately 140 ha were logged in the middle reach of the Onepua Bay (Figure 2). Planted in 1969, the stand of radiata pine was logged at age 22 to 24 years, when average standing volume was approximately 600 m^3/ha, with a stocking rate of 660 stems/ha.

The north to northeast facing slopes in the logged area average 30° and rise to a maximum height of 611 m above sea level (a.s.l.). The silt and clay textured soils on these slopes, particularly below 200 m a.s.l. where the schist bedrock is strongly weathered, are considered an important source of fine sediment during runoff (Coker, Fahey, and Payne 1993).

Logging System Description

Logging commenced in February 1992 and continued for approximately 2½ years. Figure 3 shows the progression of logging over this period.

Four logging systems were used to extract and transport wood off the site (Figure 4). The primary extraction machines comprised a Washington 88 swing hauler, a Timberjack 450C grapple skidder, and two Gantner HSW80 winch units rigged as long reach skylines.

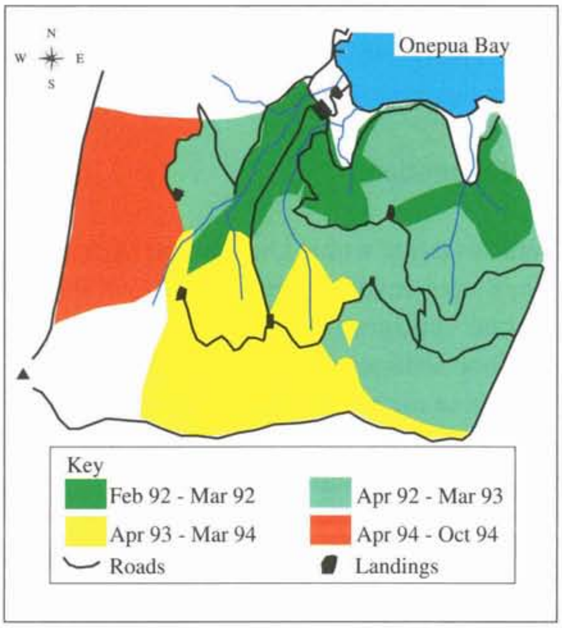

Figure 3 - Progression of logging over the 2½ year period

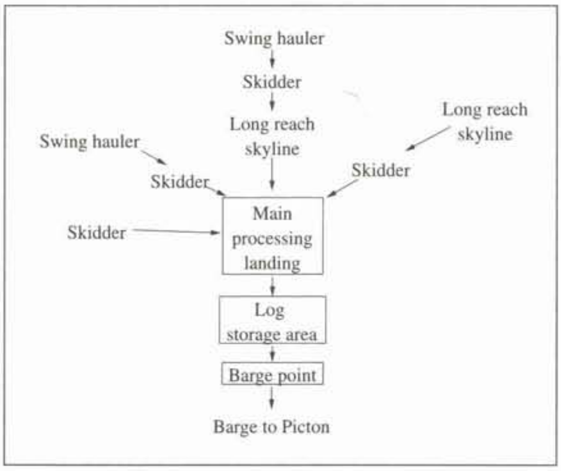

Figure 4 - Summary of the extraction and transport systems used

Several of the systems have been described in previous reports: the three-stage extraction using the swing hauler, skidder, and long reach skyline (Robinson 1993), and log transport by barge (McConchie 1993).

Logging of the slopes required the establishment of a single mid-slope contour track. In many cases, extraction by the swing hauler was directly onto this track, with the wood then being two-staged to a processing area. This resulted in few formed landings within the logged area (Figure 3).

Re-establishment after logging occurred naturally through regeneration of radiata seedlings. Colonisation by gorse was also widespread.

METHODS

Rainfall

An estimate of daily rainfall for the study area was obtained from the National Institute of Water and Atmosphere (NIWA) Port Underwood Site 142036, located approximately five kilometres southwest of Onepua Bay, on the eastern side of the range.

Marine impact surveys

Four surveys were performed by the Cawthron Institute: February 1992, March/April 1993, February 1994, and April 1995 (six months after logging was completed).

Each survey focused on the nature of the near-shore seabed (including substrate type and sediment particle size) and the characteristics of bottom dwelling plants and animals of the intertidal and sub-tidal zones.

The surveys were carried out in the near-shore regions below two sub-catchments of Onepua Bay. The Onepua Bay site was situated below a 290 ha sub-catchment, of which approximately 140 ha were logged during the study. The control site, within Missionary Bay, was below a 110 ha forested sub-catchment (Figure 2). Within each bay, five sampling sites were established along or adjacent to transects that extended from the shoreline to 210 m offshore. These transects and sampling sites were used for all surveys.

All confidence intervals and significant differences were calculated at the 95% level ($P<0.05$).

RESULTS AND DISCUSSION

Rainfall

Localised high intensity rainfall events are common in the area (Fahey and Coker 1992), with daily totals exceeding 150 mm expected with a five-year return period (Tomlinson 1980). The rainfall data for Port Underwood, is summarised in Figure 5.

During the first two years (February 1992 to 1994), the most significant rainfall events occurred during February 1993 (74 mm in 24 hours) and May 1993 (69 mm in 24 hours).

The most significant rainfall event subsequent to the commencement of logging occurred in November 1994, the effects of which were observed during the 1995 survey. Rainfall started November 5 and continued for four days, during which a total of 241 mm fell. The maximum daily rainfall during this period was 135 mm. Following this major storm and prior to the 1995 survey, the maximum daily rainfall did not exceed 45 mm.

Sedimentation

Sedimentation within Onepua and Missionary Bays was investigated by describing the seabed topography, identifying the main seafloor sediment types along the transects, and measuring the proportion of fine sediments in the upper two centimetres of the seafloor at each sampling site.

The Onepua Bay transect (Figure 6) remained relatively stable over the first two years of monitoring. Minor changes to the seabed during the third year were exhibited by a shoreward spread of the offshore soft mud. In the 1995 survey, terrestrial debris, comprising mainly woody pine and lesser amounts of native vegetation, was more widespread, but less dense than previous years.

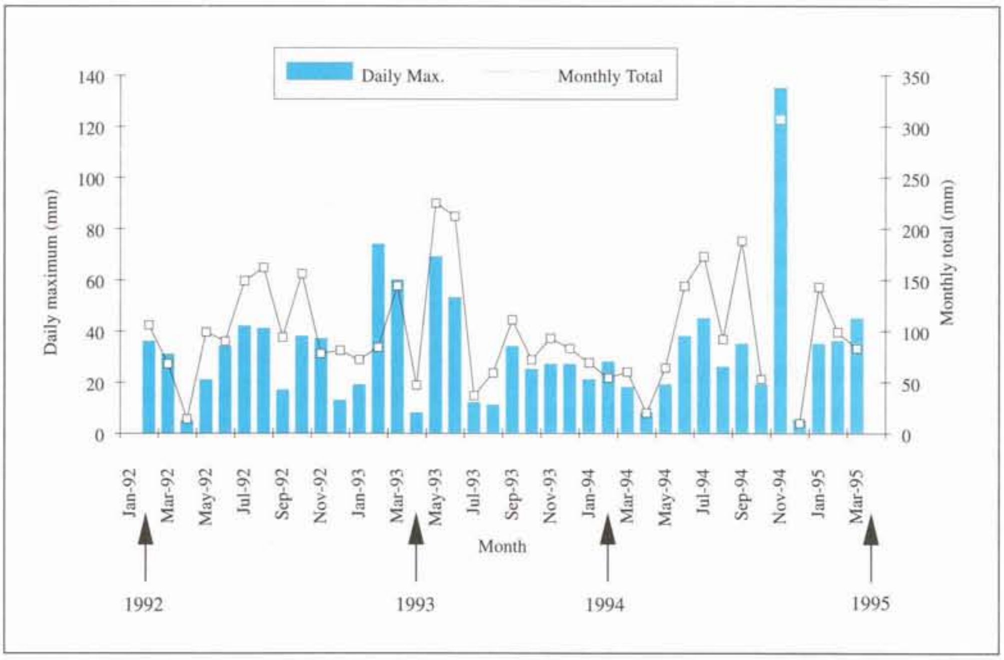

Figure 5 - Maximum daily rainfall each month, and monthly total rainfall for the period of the study. The timing of the marine surveys is shown

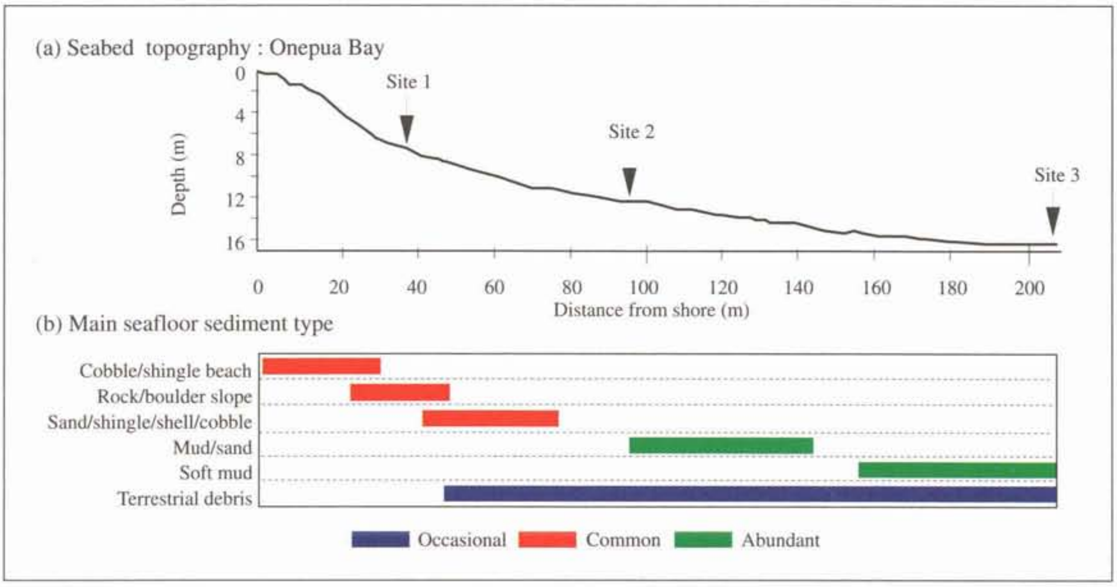

Figure 6 - Seabed topography, sampling site locations and main seafloor sediment types on Onepua Bay transect, April 1995. Sites 4 and 5 (not shown) were located perpendicular to the transect, between Sites 2 and 3

Whereas logging at Farnham Forest increased erosion, causing deposition of fine sediments in near-shore regions (Johnston *et al.* 1981), a significant increase in deposition of fine sediments was only exhibited at one Onepua Bay sampling site - Site 5 (Figure 7(a)). Furthermore, a significant decrease in fine sediments was seen at Site 2 over the three-year period.

The shallow regions of the Onepua Bay transect (Sites 1 and 2) were characteristically devoid of fine sediments. The proportion of fine sediments appeared to increase with increasing depth (Figure 7(a): Sites 1<2<4<5<3). This indicated that wave and current action were sufficient to prevent near-shore fine sediment accumulation.

The 1995 survey noted delta formation at the mouth of the two streams entering Onepua Bay. The streams formed cobble and shingle deltas which were relatively free of fine sediments. The smaller eastern stream drained an area of cutover where a landslide had occurred during the November 1994 storm.

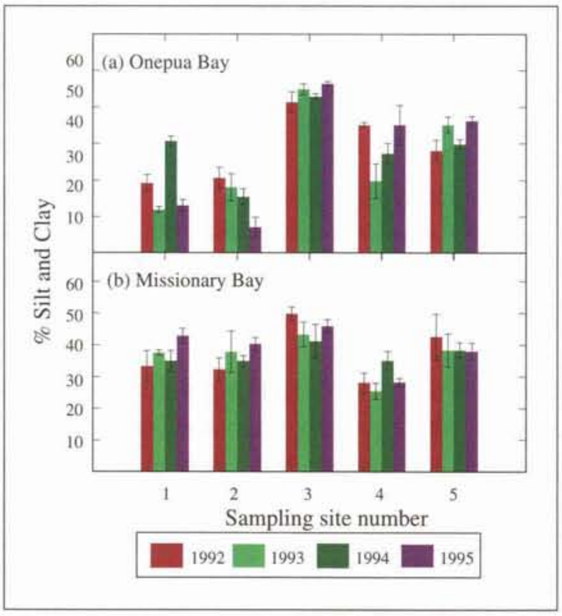

Figure 7 - Mean (± confidence interval) percentage of fine sediments (silt and clay) found in replicated cores taken at the sampling sites in (a) Onepua Bay and (b) Missionary Bay.

The establishment of the transect and sampling sites at Missionary Bay aimed to provide information on background sedimentation. Between the 1994 and 1995 surveys, a large delta formed in the vicinity of the stream mouth in Missionary Bay despite the catchment remaining forested. Extending 35 m off shore, soft shingle and

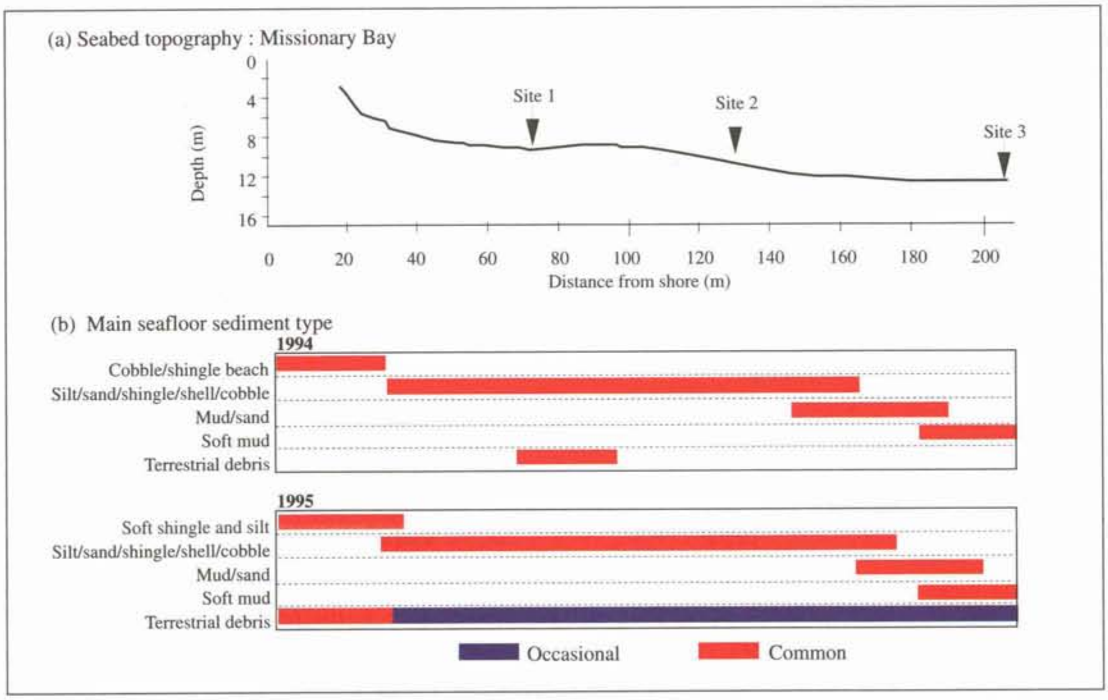

Figure 8 - Seabed topography, sampling site locations and main seafloor sediment types along the Missionary Bay transect, February 1994 and April 1995. Sites 4 and 5 (not shown) were located perpendicular to the transect, between Sites 2 and 3

silt covered the pre-existing cobble and shingle beach (Figure 8(b)). The extent of terrestrial debris had also increased markedly in 1995.

Despite the major changes in shoreline seabed topography, proportions of fine sediments remained relatively uniform over the three years (Figure 7(b)). Fine sediments were a feature of the shallow near-shore areas in Missionary Bay, contrasting with the Onepua Bay transect.

As Missionary Bay is located further from Tory Channel, wave action and tidal current energy are likely to be less than at the Onepua Bay site. Therefore, differences in fine sediment deposits exhibited between the two bays may reflect differences in near-shore sediment flushing.

In addition to the near-shore monitoring, fine sediment levels were also monitored at four sites within the deeper water of central Onepua Bay. These results are not presented in detail here because of the unknown contribution from other sub-catchments within Onepua Bay. However, during the study period, there were no major changes in fine sediment deposition at these sites. Furthermore, if there had been it would have been difficult to link these changes with near-shore flushing within either of the study bays.

Sediment analyses showed that concentrations of total organic and tannin-like substances at all sampling sites were within ranges expected for the region.

Marine Life

The effects of logging on marine life within the Onepua and Missionary Bays were investigated by identifying and quantifying visible seafloor plants and animals, and sediment dwelling animals.

Seafloor animals and plants observed along the Onepua Bay transect were similar in the successive surveys. Any changes which may have been caused by the November 1994 storm were no longer evident six months later. Therefore, it can not be ascertained if the marine life was adversely affected during the storm, and had since returned to expected levels. If re-colonisation had occurred, this would have been aided by the wave action which removed fine sediments from shallow regions.

The apparent stability at Onepua Bay was in contrast to that on the shoreward end of the Missionary Bay transect (Figure 9). Flooding and delta formation either washed away or buried near-shore encrusting communities of barnacles, chitons, top shells, triplefin *sp,* and tube worms. Mobile animals may have also been displaced by storm-induced disturbances, but had re-colonised by the 1995 survey. Plant and animal associations away from the stream mouth remained much the same as previous years.

A slightly different result was depicted by detailed analyses of the species and abundance of sediment dwelling animals within the two bays (Figure 10(a)).

Over the period of the four surveys, no clear patterns of change in species richness (the number of different types or taxa of bottom-dwelling animals living at a particular site) were discernible in either bay.

Figure 9 - Stream delta in Missionary Bay, five months after the November 1994 storm

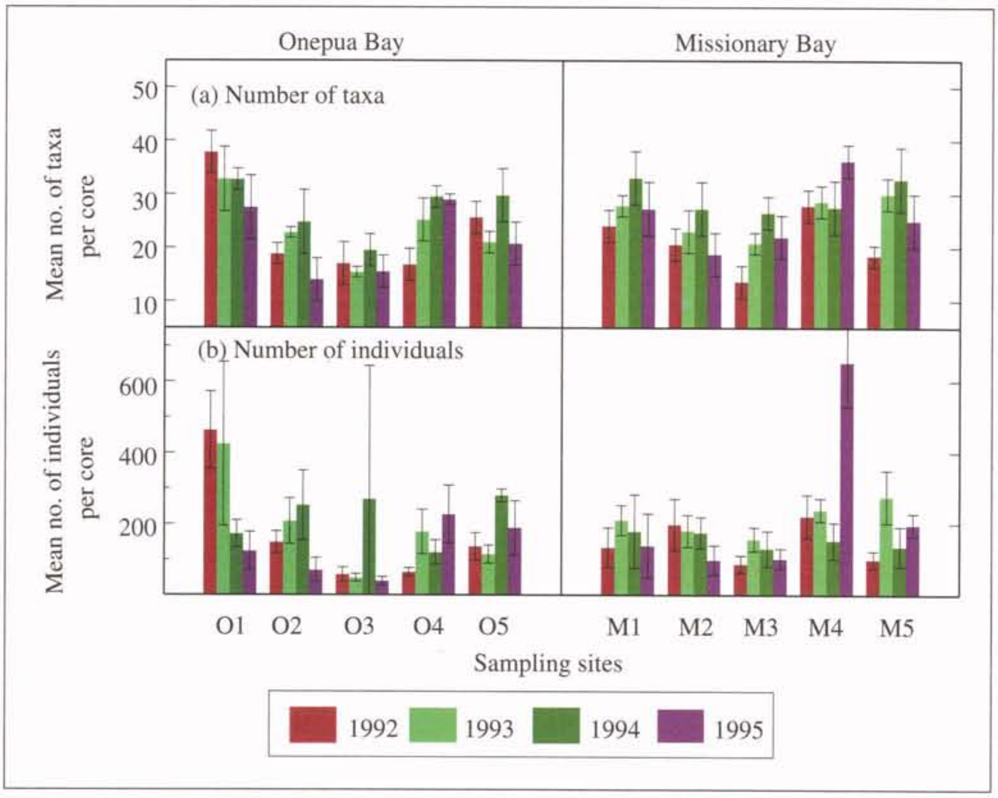

Figure 10 - Mean (± confidence interval) number of (a) individuals and (b) taxa found in top 2 cm of replicate cores of the seabed collected at Onepua Bay (Sites O1-O5) and Missionary Bay (Sites M1-M5)

Of the observed changes, a reduction in taxa occurring at Onepua Bay Sites 1 and 2 was the most pronounced. Site 1 exhibited a significant decrease over the monitoring period but was not significantly affected by the 1994 storm. In contrast, Site 2 exhibited only minor fluctuation prior to the storm that caused a significant decrease in taxa numbers.

Since species richness is a good indicator of environmental stability, it is reasonable to assume that the observed changes, as of April 1995, were related to disturbances of the seabed in which the they live.

Significant decreases in the mean number of individuals per core (another potential indicator of disturbance) were also observed at a number of sites in the 1995 survey. Again, these were most pronounced adjacent to the logged catchment of Onepua Bay, but significant reductions also occurred at one of the Missionary Bay sites (Figure 10(b): M2). These changes in the community structure of invertebrates coincided with increased storm activity approximately six months prior to the survey, but no clear distinction can be made between sites adjacent to the logged versus the unlogged sub-catchments.

Variations in abundance within individual taxonomic groups were subtle, and not readily attributable to logging activities. In some cases (for example, molluscs) the variations appeared to represent natural year-to-year fluctuation. Where significant variations were observed (for example, amphipods and polychaetes), they were not limited exclusively to either study location.

Storm-induced delta formation in Missionary Bay indicated considerable changes to the physical and biological habitat of the shoreline (intertidal to shallow sub-tidal) environment. However, this was not reflected by changes in marine life further off shore. Furthermore, significant changes in fine sediment deposition and/or marine life within both bays, prior to the November 1994 storm, is evidence of considerable natural fluctuation.

This study has highlighted the inherent difficulty in establishing the extent to which logging activities affect the near-shore marine environment. Not only do the logged and unlogged sub-catchments need to be similar, it is also necessary to confirm that near-shore conditions and processes are also similar prior to logging.

CONCLUSIONS

The effects of logging on the near-shore marine environment within Onepua Bay were monitored annually over the three year period, 1992 to 1995. The marine surveys were replicated in the near-shore zones below two sub-catchments: Onepua Bay, below a logged sub-catchment; and, Missionary Bay, below an unlogged sub-catchment.

Measurements at two near-shore sampling sites within Onepua Bay showed a significant decrease in fine sediments and benthic animals over the three years. This contrasted with Missionary Bay, which showed significant fine sediment accumulation in the near-shore region.

The lack of observed near-shore fine sedimentation at Onepua Bay, and the stronger change in seabed animal associations at Missionary Bay, indicated that factors other than logging, such as natural sediment input and flushing of fine sediments, were responsible for the observed changes over time. Despite the absence of near-shore sedimentation related to logging, it is recognised that accumulation of fine sediments within central Onepua Bay may occur over the longer-term, particularly as more of the catchment is logged.

REFERENCES

Coker, R.J., Fahey, B.D., Payne, J.J. (1993) : Fine sediment production from truck traffic, Queen Charlotte Forest, Marlborough Sounds, New Zealand. *Journal of Hydrology (N.Z.)* 31(1): 56-64.

Fahey, B.D. and Coker, R.J. (1992) : Sediment production from forest roads in Queen Charlotte forest and potential impact on water quality, Marlborough Sounds, New Zealand. *N.Z. Journal of Marine and Freshwater Research* 26: 187-195.

Johnston, A., Mace, J, and Laffan, M. (1981) : The saw, the soil and the sounds. *Soil and Water* 17(3/4): 4-8.

McConchie, M. (1992) : Log transport by barge - A case study in the Marlborough Sounds. *LIRO Report* 17(18): 10p.

Robinson, T.D. (1993) : Wood transport using a long reach skyline. *LIRO Report* 18(20): 8p.

Tomlinson, A.L. (1980) : The frequency of high intensity rainfall in New Zealand. New Zealand *Ministry of Works and Development, Water and Soil Division, Water and Soil Technical Publication* 19: 36p.

Turland, J., Wakelin, S., and Lane, P. (1993) : *National Exotic Forest Description: 1992 National and Regional Wood Supply Forecasts*. New Zealand Ministry of Forestry, Wellington: 147p.

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